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THE CONSTITUTION
OF
THE ANIMAL CREATION
AS EXPRESSED IN
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THE CONSTITUTION
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ANIMAL CREATION
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STRUCTURAL APPENDAGES.

BY

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"It is not to be expected in any difficult undertaking, of whatever kind, that the same person who sows the seed should also reap the harvest; but there must, of necessity, be a preparation, and gradual progress to maturity."—Bacon.

LONDON:
JOHN CHURCHILL, NEW BURLINGTON STREET.

MDCCLVII.

1863, Jan. 14.

Bequest of
John Bunistrad Tassenden, S.S.
of Jamaica Plain.

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KF 27651

TO
THOMAS CHAMBERS, Esq.,

(Of the Firm of NEWTON, CHAMBERS, & Co., Thorncliffe Iron Works, Chapeltown, Sheffield.)

THIS WORK IS INSCRIBED;
AS A SINCERE TESTIMONY OF RESPECT FOR HIS CHARACTER,—
GOOD WITHOUT PRETENSION,—
BENEVOLENT WITHOUT OSTENTATION,—RELIGIOUS WITHOUT BIGOTRY,
AND EXEMPLARY IN ALL THE SOCIAL RELATIONS OF LIFE:
NOR IN COMMERCIAL PURSUITS,
IS HE LESS DISTINGUISHED BY INTELLIGENCE,
ENTERPRISE, AND INTEGRITY :

BY HIS OBLIGED FRIEND,

G. CALVERT HOLLAND.

PREFACE.

EVERY effort tending to elucidate the organization and functions of the animal creation, deserves attention according to the measure of its success.

Numerous as the labourers have been in this vast department of study, and imposing as the knowledge is resulting from their genius, devotion, and enterprise; the field so ably cultivated is, nevertheless, undiminished in its riches and attractiveness. The truths they have established are the starting points whence other inquirers proceed in the path of discovery; and to the mind awakened to their value, and justly interpreting their significance, they shed a light in advance, opening out higher and more comprehensive views of nature.

The subjects of which the author has treated in the following pages, will at least have one claim to consideration,—the novelty of the researches to which they have given rise. This is not, however, urged as a merit; for what is estimable consists not in that which is new, but in what is sound and susceptible of application. He has endeavoured to explain the origin and use of important appendages of the

animal body, which have hitherto received little notice from the physiologist ; nor has the latter attempted to trace the organic necessities to which they owe their existence, or the end to which they are subservient in connexion with the powers of life.

Should the author have failed in satisfactorily accounting for the growth of them, the aspects and relations in which they are contemplated, and the life and interest imparted to phenomena, that may by many be considered as scarcely falling within the domain of scientific investigation, will probably enable others, possessing larger powers of mind, and far greater acquirements, to look deeper into the works of creation.

The errors and defects of a writer, who thinks boldly and independently, are not without utility in the stirring influence they exercise. To excite thought and stimulate inquiry, whatever be the objects to which they are directed, is to accelerate the progress of knowledge.

In the language of an admirable philosopher, "it has been well and justly said, that 'every *desideratum* is an imperfect discovery,' " to which it may be added, that every new problem which is started, and still more every attempt, however abortive, towards its solution, strikes out a new path which must sooner or later lead to the truth. If the problem be solvable, a solution will in due time be obtained : if insolvable, it will soon be abandoned as hopeless by gene-

ral consent ; and the legitimate field of scientific research will become more fertile, in proportion as a more accurate survey of its boundaries adapts it better to the limited resources of the cultivators."

The author, in justice to himself, deems it necessary to observe, that the work now given to the public, though complete in itself, contains only the first half of his researches concerning the supplementary organs of the animal kingdom. The other portion is equally ready for the press, but he withholds it on these grounds : if the principles advanced be true, it will scarcely be denied that they constitute an important step in physiology : but if false, the fallacies are indeed of a grave character. Afraid of multiplying the latter, he adopts the course, whether wise or not, it is for others to decide, of offering this part of his undertaking, in order to elicit the sentiments of impartial and competent authorities. At the same time he must be allowed to state, that the further investigations into which he enters, abound in facts and illustrations bearing on the principles in question, conferring upon them greater fulness and clearness of exposition, and proportionately strengthening the foundation on which they rest.

In conclusion, it may be remarked, that the views unfolded have an application to the vegetable as well as the animal kingdom, the former, equally with the latter, having particular structures which may be regarded as supple-

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CHAPTER XIII.

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CHAPTER I.

THE NATURE OF THE OBJECTS CONTEMPLATED IN THE PROPOSED INQUIRY.

WE are not insensible of the difficulties which lie in the path of the present undertaking. The most formidable will be the inadequacy of our knowledge to do justice to it. The successful accomplishment of it requires attainments to which we can lay no claim in the variety and extent of the researches which it implies.

In those departments of the inquiry in which our deficiencies were most felt, we have spared no labour in the endeavour to become familiar with the subjects to which they relate, so far as they had an immediate reference to the general scope of the principles which it is our intention to unfold.

The accuracy of our views will not altogether depend on the profundity of our acquaintance with animal or vegetable nature. If they are shewn to establish beyond dispute the circumstances which necessitate the growth of a particular class of appendages, in relation to the vital powers of the animal or plant, we may with strict philosophical

justness infer, that other supplementary productions, the same in their general character, though different in form and structure, are the result of similar constitutional and local actions.

The task on which we enter is one of no ordinary kind. It has little in common with previous physiological investigations. We mention this not as a ground of merit, or to secure the indulgent consideration of the critic, but as an apology for defects of which we are fully conscious. The novelty of the views will probably be fruitful in the suggestion of objections which would not have been urged, could we in any degree claim for them the support of a Cuvier, an Owen, or a Geoffroy Saint Hilaire. Such names have a weight and authority not easy to overrate. We are aware of the wide difference between their position and our own in the scientific world; and the being sensible of it has not been without its utility in the influence it has exercised on the researches which have long occupied our attention. The doubts to which it naturally gave rise inculcated caution—a repeated examination of the field we have traversed, and certainly imparted to the process of analysis, a refinement which it would not otherwise have possessed. We have anxiously laboured to establish the justness of the principles advanced.

For more than thirty years we have zealously cultivated physiological pursuits; and from no other motive than a desire to arrive at truth, and, if possible, to enlarge the boundaries of a science of vital importance to humanity.

The hair has been studied, and elaborately, in its anatomical conditions, and in its relations to the tissues

in which it originates ; but the function which it exercises in the animal economy, or the causes to which it owes its growth, have awakened no particular interest in the physiological inquirer. With few exceptions, the only remarks which it has suggested have been in reference to its imagined utility as a covering or protection to the parts to which it is distributed ; or as an appendage adding materially to the beauty of the human figure. This, however, is to take an extremely limited view of the end which it serves, and the circumstances which give rise to its production.

If, as it is stated, the hair of the head is intended to protect it from external injuries, or to keep up its natural degree of heat, we may reasonably ask : Why does it, after the prime of manhood, disappear to a great extent from this particular region ? It decays, and leaves a smooth polished surface, when, clearly, it is most urgently required for the purpose assigned to it. The feeble and unsteady step, and the impaired senses, render the aged liable to accidents, which the provision in question, according to such reasoning, would in some measure mitigate. If, however, we regard it as a covering to the parts in which it exists, maintaining their normal temperature, or protecting them from the prejudicial effects of cold, it is evident that a large portion of it falls off from the head, when the body is struggling to carry on its operations with deficient vital energy, and a greatly diminished generation of animal heat.

These considerations alone, independently of others that might be urged, are so directly opposed to the ideas entertained concerning the use of the hair, that we may, without

presumption, consider them as unsound or inadequate to account for the important purpose implied in its development. They are not in harmony with the works of nature, as far as these are capable of being interpreted. Had it been given for either of the objects mentioned, it would have been found in the greatest abundance when the animal system most needed it. Utility, which expresses supreme wisdom, characterises all the manifestations of Omnipotent power. The contemplation of this principle, steadily kept in view, especially in certain departments of science in which objects appeal strongly, and under peculiar conditions, to the senses, often leads to valuable discoveries. In the investigation of the productions of Nature, the question cannot too frequently recur: To what end are they subservient? Utility, and not beauty, as a mere external ornament, is stamped upon the infinite variety of her works. This principle governs the creation of them. The beauty is in the mind of the observer, and the ideas which it awakens, whether in connexion with the animal or plant, originate in qualities which have for their foundation utility of some kind; —qualities which are a necessity springing out of vital actions, whether instrumental to the development of exquisite forms or brilliancy of colours. As these actions are modified by the interference of man or the variable influences of nature, fresh exigencies arise for the expression of them. Numerous illustrations of this fact, and possessing no ordinary interest from the importance of the objects introduced, will be furnished in the course of the following researches; and, if the physiological views here brought forward be based on justly interpreted principles, they will

be found to afford a satisfactory explanation of the changes which arise.

These remarks on beauty are intended to apply only to the objects which this inquiry contemplates. We have no new or modified theory on the subject to offer. We accept the conclusions at which modern philosophers have arrived; and from one of the most recent of them, to avoid popular misapprehension, we quote the following passage, in the sentiments of which we fully agree:—"Beauty is not an inherent property or quality of objects at all, but the result of the accidental relations in which they may stand to our experience of pleasures or emotions, and does not depend upon any particular configuration of parts, proportions, or colours, in external things, nor upon the unity, coherence, or simplicity of intellectual creations, but merely upon the associations which, in the case of every individual, may enable these inherent, and otherwise indifferent qualities, to suggest or recal to mind emotions of a pleasurable or interesting description."*

The acute critic, in his admirable disquisition on this subject, has scarcely, we think, done justice to Diderot; nor did he, in our opinion, fully seize the views of the latter in reference to his ideas of *relation* in connexion with objects recognised as beautiful. The principle of the French philosopher is susceptible of very extensive application, and is in active operation in our minds from childhood, upwards, adding important elements to the sum of those feelings which are peculiarly pleasurable.

If the human being had not been invested with hair upon

* Article *Beauty*. Vol. ii. part 1. Encyclopædia Britannica. By Lord Jeffrey.

the head, and in the several regions of the face, the presence of which appears indispensable to our notions of loveliness, dignity, or character of expression, the human figure would no less have excited agreeable emotions; and had a solitary individual fallen under our notice, displaying these appendages, how startled and shocked we should have been at the aspect of such a monstrosity! The same remark is equally applicable to every form and lineament of animated nature. It is, therefore, the duty of the philosophical inquirer not to be arrested in his investigations by hasty conclusions, which may be forced upon the mind by the superficial observation of organic provisions, supposed to be satisfactorily accounted for from their gracefulness, or the consideration of some insignificant end to which they are instrumental.

It is neither unimportant nor uninteresting, in a scientific point of view, to state the facts and reasoning which originally led to this investigation. It was certainly not entered upon as an exercise of ingenuity or of speculative ability, or from an ambitious desire to occupy ground which had been little cultivated.

The subject unexpectedly presented itself in the course of an extensive inquiry into the properties and functions of the nervous system. While engaged in this pursuit, tracing the influence of nervous matter in the processes of life, and ultimately referring all vital operations to its agency; and, further, discovering that every organ, whatever might be its action, was a medium not only for the expenditure of nervous power, but the emission of useless elements, portions of which necessitated an outlet, and in forms not hitherto

contemplated by the physiologist; the attention was directed to the study of the supplementary structural provisions which occur in connexion with nervous matter under particular circumstances.

The nervous tissue offered itself to our view under two very different conditions. In the one case, the energy with which it abounds was expended, or had an issue in the discharge of important functions, as in the formation of the several secretions, as the gastric and pancreatic juices, bile, urine, and semen; and likewise in all muscular motions, whether manifested by internal or external organs. In the other instance, we have an accumulation of nervous matter, as the contents of the cranium, in the face, axilla, and in the region of the pubis, the animating principle of which, or the superfluous matters to which it gives rise, *have no outlet analogous to that possessed by nerves in other situations*; and hence the presence of hair in certain localities.

It is not necessary on this occasion to expatiate at large upon these facts. It is evident that the brain is an exceedingly active organ, the operations of which are not distinguished by any secretions like those to which we have alluded, or what falls under actual observation. It cannot be doubted, for it is a law pervading both animal and vegetable nature, that every vital process, whatever may be its office, conduces not only to a definite result essential to the well-being of the individual; but, further, is accompanied by the discharge of useless substances, the properties of which we may leave for subsequent consideration: the excretion of them is indispensable to the normal or healthy actions of the structures by which they are produced.

We will endeavour to render our meaning clear and intelligible. The stomach, the liver, the pancreas, and the small intestines, contribute their vital resources towards the accomplishment of the digestive process. On the completion of it, matters arising from the action of these organs accumulate in the alimentary canal, useless for the purposes of nutrition, and prejudicial if retained, are expelled in the condition of *faeces*. It may further be observed, that every organ of the animal economy, according to its capacity, function, and activity, relieves itself of various chemical elements, the residue of vital processes, and are ultimately thrown off by the kidneys, the skin, the lungs, and the intestines.

The regions where hair abundantly exists, as the head, face, pubis, axilla, and frequently the chest in the male, are the seat of, as well as in the vicinity of, excited vital actions; and the superfluous matters which these create have to be expelled, and a great proportion of them finds an external issue in connexion with the tissues which generate them. These tissues are very differently circumstanced, from the internal organs to which we have adverted, both with respect to the character of the operations carried on in them, and the nature of the organic results to which they give rise. The conditions peculiar to each will be further illustrated.

The distinction which is here pointed out, is one not only indisputable, but obvious to the most ordinary understanding, and has a direct application to the subject in hand. We may mention another difference between organs, the exercise of which occasions dissimilar effects, not less in reference to the materials which are appropriated to the necessities

of the animal system, than what is useless and thrown off from it.

One class of organs may be regarded as gross in the nature of their productions, as in the formation of gastric juice, bile, and other secretions ; another may be viewed as refined in the functions which they exercise,—the uses to which they are subservient, and equally so the residuary elements which have to be emitted to maintain them in healthy operation.

The brain, for example, in the actions which it performs, has little in common with those of the stomach, liver, and intestines. It is the seat of thought and feeling, and the manifestation of them constitutes one of its important functions. They are in fact its productions, as the gastric juice and bile are of their respective organs, and are to be traced to the co-operation of blood and nervous power distributed to, and pervading cerebral matter.

The mode in which mental states originate or act is foreign to the inquiry. It would be a waste of time to speculate upon the subject, and not less so in regard to the manner in which the ordinary secretions of the body are effected. We have to deal with the simple fact, that all mental processes are accomplished at the expense of blood and nervous energy, or whatever name we give to that agent which is the animating principle of the nervous tissue. This broad conclusion will not be questioned. The admission of it will allow us to advance a step further in the analysis in which we are engaged.

The operations of the mind can scarcely be viewed as creating any residue or useless matter, either in degree or

kind analagous to what is consequent on the exercise of the abdominal viscera. The cerebral actions, instrumental to thought and feeling, will deprive the blood and nervous substance of certain elements. They must occasion the escape of something, otherwise the brain would not be enfeebled by severe or uninterrupted exertion. As already stated, every vital action implies waste, and, in reference to the cerebrum, this is evidently great. The immense mass of nervous tissue appropriated to the mental faculties, and the large amount of blood transmitted to it, are conditions which may justly be considered as a measure of the demands made upon the brain.

It was in the course of the physiological investigations alluded to, establishing the distinction between the two classes of organs, in respect of the nature of their operations, and the changes they effect in the constitution of the blood, that the important use of the hair in the animal economy suggested itself.*

On the views stated, so far from being unexpected or strange, it was perfectly natural that this, or some similar supplementary provision, should be found in connexion with those regions of the body most richly endowed with nervous substance, and contributing to functions predominantly nervous, as thought and emotions—the expression of the countenance, and the exquisite sensibility bestowed on the generative system.

We are simply stating, on this occasion, the considerations which led to this inquiry, and not arguing for the justness of the inferences deduced. The facts brought

* *Practical Views on Nervous Diseases.* London, 1850.

forward clearly demonstrate a wide distinction between the two classes of organs, as to the nature of their functions and the influence they exert on the properties of the blood. It is evident that where nervous matter is concentrated in masses, or liberally distributed to particular structures, the actions of which are largely nervous, and not less so in muscular movements, the corresponding superficial regions, in man, are abundantly invested with hair.

Having, in the prosecution of previous researches, arrived at these general conclusions, showing a necessary connexion between the existence of hair and a special class of vital operations, another branch of the subject presented itself, which certainly at first offered difficulties: viz., *the cause of the difference in the distribution of this external appendage in the two sexes*. The discrepancy is remarkable; yet we felt convinced that, if the principles, which it was our object to develop, were sound, they would be capable of furnishing a satisfactory explanation of the phenomena.

On the views which we have unfolded in the subsequent pages, in reference to the origin and use of a variety of external appendages distinguishing the human species, the lower animals, and the vegetable creation, we have experienced no difficulty in accounting for the difference between the sexes in regard to the growth and distribution of hair. The thorough elucidation of the subject throws considerable light on the functions of the animal economy. It shews how one class of organs, common to one sex and wanting in the other, modifies the entire character of the living structures.

The uterus, in woman, from the first moment of the establishment of its important office to the final cessation of its activity, is a centre of vital operations, the tendency of which is to draw the nervous energy from without, inwards, giving it a sphere of employment essential to the healthy condition of the organ, and of its susceptibility to impregnation.

This centre exerts a radiating influence, which, through the agency of the brain, of the spinal cord, and of nerves, is transmitted to the mammæ, the haunches, thighs, and other parts. The breasts enlarge, become fully developed, and in their turn awaken sympathetic relations with the whole body. In a word, the life of the female is principally internal, and predominantly abdominal. A limited amount of nervous energy is distributed to the cutaneous surface, *and this is one of the causes of the absence of hair in those regions in which it is copious in man.*

In the male of the human species we observe very different vital conditions. The organs of generation are external, and the procreative fluid they secrete is highly stimulating in its nature, and, whether from absorption or not, is the cause of extraordinary effects in the animal economy. The sensations which it is influential in arousing, impart new life and interest to man. Powerful mental emotions are excited. The brain and the generative system act and re-act on each other, and through them, the whole of the nervous system is enabled to enter on more extensive and vigorous operations; and, as we shall subsequently shew, necessitate the existence of an external structural provision, as the hair in certain regions, which in woman are destitute of it.

The explanation of these phenomena forms a very small portion of the subjects of which we shall treat in the course of the proposed inquiry. We allude to them, on this occasion, as illustrating the train of reasoning which originally led to the contemplation of the appendages of the animal body. There is no better test of the soundness of principles, than the measure of their application to facts, numerous and diversified, and apparently possessing little in common. To be equal to the requirements which these impose,—in a manner obvious and natural, as if they had been the suggestion of them individually, if not evidence of truthfulness, establishes, at least on their part, a strong claim to a candid and patient examination.

The transition from one step of the investigation to another, further in advance, and in new directions, embracing phenomena, which to superficial observation have scarcely any relation to each other, was accompanied with no embarrassment or sense of difficulty, which, in our opinion, is to be traced to the justness and comprehensiveness of the principles by which we are guided throughout these researches.

On discovering the vital conditions occasioning the growth of hair, and the end which it serves in connexion with the general functions of life, other matters, kindred in character, rapidly presented themselves to the mind—as baldness, grayness, or whiteness of the hair—not merely as they occur in advanced years from the decay of the vital powers, but under a variety of circumstances.

We had, further, to consider, why the two sexes offer many points of discrepancy in regard to these conditions.

The female is much less subject than the male to baldness and changes in the colour of the hair. To explain satisfactorily these differences, it was necessary to ascertain what was peculiar to the constitution of each, and the analysis clearly shewed, that the phenomena were in perfect harmony with the prevailing vital functions of the individuals.

The further prosecution of the inquiry opened out new views on other subjects, fraught with considerable interest to the physiologist, but which certainly have not hitherto been understood.

After the prime of life, the female gradually approximates in form to the male. The haunches and the thighs lose much of their characteristic development, the mammæ become flaccid, and in many instances are completely absorbed; and, lastly, hair frequently appears in more or less abundance on the lip and chin.

The principles are shewn to be equal to the explanation of these effects. They point out the laws according to which they occur, and establish their application to many of the lower animals, as the extraordinary structural modifications displayed by many of the latter, when from age they cease to exercise particular functions.

We were led by these researches to the study of other changes, though of rare occurrence. In extremely advanced years, the hair, after having been snowy white for half a century, regains its original colour, and continues in this state until death;—new teeth are likewise at times cut;—phenomena which would almost indicate on the part of nature an effort to recover the vigorous endowments of youth.

These singular results are shewn to be explicable on the views on which we have accounted, and, we trust, in a satisfactory manner, for numerous other organic changes; and the arguments adduced are shewn to be strengthened by analogous facts occurring in the vegetable kingdom under similar circumstances.

After an elaborate examination of the causes of the growth of hair, we have endeavoured to determine the constitutional and local influences by which its development and colour are affected. In treating of the latter, we have pointed out the excited and depressed state of the cranial nerves, in some cases partially, and in others generally, diseased. Among the more important of the constitutional causes, *is the tendency to the deposition of fat*. We have attempted to prove that the production of this is evidence of diminished nervous energy, and is accompanied with a state of the blood implying inferior vital conditions. We have shewn that the development of the adipose tissue is antagonistic to the vigorous growth of hair, both in man and the lower animals, and also of other external appendages belonging to some of the latter.

The investigation of these subjects has occupied considerable space and time; nor has it been exempt from much anxious thought. Aware that we were treading on new ground, turning up soil in various directions to which attention had not previously been given, a feeling of more than ordinary solicitude was natural, in reference to the principles advanced, and the soundness of their application.

The views, if founded on truth, were clearly suggestive of more extended researches with respect to the animal crea-

tion at large. Many of its numerous forms, especially the more interesting of them, have their characteristic external appendages, which may be studied as general and particular. The elephant has its tusks—the horse and the lion their manes—stags their antlers—oxen and certain sheep their horns—Siberian swine their bristles and frizzled woolly hair. The more beautiful of the feathered tribe exhibit an immense variety of supplementary structures; some of them so extraordinary in character, and so marvelously rich and diversified in colours, that Nature, in the production of them, appears to have sported in the most felicitous and frolicsome of her moods. Many of these exquisite appendages are the exclusive endowments of the male, and the distinguishing ornaments of the season of love. With the termination of this, the male often assumes the sober and unobtrusive garb of the other sex.

The principles which explain the growth, decay, and use of hair in the human species, should be capable of being applied with equal force to the elucidation of all other forms of external appendages throughout the animal creation. Nature acts by general, and not partial, laws. The organic necessity which gives rise to hair on the face of man, produces the tusk of the elephant, the mane of the lion, and the magnificent tail of the peacock. They severally owe their origin to a *necessity* of the animal system. They are supplementary organs developed in the ratio of the activity of more important tissues, and they offer themselves as a means for using up the superfluous elements created by the latter. In the course of the inquiry, numerous facts are brought forward in support of these conclusions, and we

must entreat the reader to suspend his judgment until the subject has been placed fully before him.

The distinction we have established between *essential* and *supplementary* organs, and on which we have dwelt at some length, will be found to account for many strange and singular structures displayed by the animal kingdom. The former class of organs may be influenced, and to an extent far exceeding ordinary conception, by a variety of external circumstances; and every change in their structural and functional condition *modifies the development and form of the supplementary*.

In the further unfolding of these views it became evident, that the application of them was not limited to the animal kingdom. The vegetable creation abounds in external organic productions, which may with equal propriety be designated the appendages of the plant, and, in fact, they are termed by the botanist, accessory organs. These, like those of the animal, may be shown to express similar vital necessities. Some of them appear and disappear; are variously affected in form and function, and in the degree in which they are thrown out, according to the constitutional or local conditions of the plant.

The study of the vegetable kingdom possesses considerable interest, in consequence of the difficulty experienced in attempting to explain the growth and use of various organs, among which we may name the spina, aculeus, cirrus, and pilus. The speculations to which these have given rise, concerning the end they serve, are much of the same kind as those which have been entertained by writers as to the use of tusks, horns, and hair, and certainly have scarcely

the merit of ingenuity. Their utility, as we shall endeavour to shew, consists rather in being evolved as a relief to the plant, than in any important functions which they exercise. The search after the latter is a fruitful source of the hypotheses which have been suggested in reference to their office.

In conclusion, we may observe, that throughout these researches we have constantly to allude to the properties and agency of the nervous system. In the animal kingdom, whatever structural alteration takes place, it is invariably the result of a primary change in nervous matter. This alone is susceptible of external impressions, and according as it is influenced, modifications occur in the organization and actions of the body at large, or in its several regions ; and in the latter instance, they express particular constitutional as well as local exigencies.

We contend that the nervous system is pervaded by an agent susceptible of accumulation and dispersion, and varying in its distribution to organs according to their requirements, which, in the ordinary operations of the animal system, are inconstant and irregular. We regard nervous matter as merely a medium for the transmission of the nervous principle ; and that this, in strictly scientific language, not only has nothing in common with the nervous tissue, but is as distinct from it as the blood is from the vessels in which it circulates. The brain and the spinal cord are the sources from which it is derived, and it flows from these to the nerves as channels for its general diffusion, in the ratio of the vital actions to which they contribute.

CHAPTER II.

REMARKS ON THE TISSUES AND FUNCTIONS OF THE SKIN,
AND THE STRUCTURE OF THE HAIR.

THE differences among anatomists concerning the organization of the skin, are remarkable. There is, however, less discrepancy as to the functions which it exercises; and an accurate knowledge of these is of far greater value in relation to the researches in which we are engaged, than a profound acquaintance with the structure of the cutaneous tissues. The diversity of opinions with respect to the latter, will not in any degree affect the conclusions that may be drawn from the former.

We shall consider the skin as composed of the epidermis or cuticle, the rete mucosum, and the corion or *cutis vera*. The epidermis, or external covering, is a thin semi-transparent membrane, connected by its under surface with the parts with which it is in contact, adapting itself to all their inequalities. It possesses neither nerves nor blood-vessels, nor is it endowed with sensibility. It varies in thickness in different regions of the body. In the palms of the hands, and the soles of the feet, where it is much used

and subject to pressure, it is most developed. It is stated to be inorganic, and as it is worn or destroyed by attrition, is successively renewed by secretion from the outer surface of the corion.

Although the cuticle affords passage to the hair, and to sensible and insensible perspiration, no openings have been discovered in it. On this point, probably with the exception of Bichât, anatomists are unanimous. The phenomenon is explained on the supposition that it possesses a species of elasticity. Bichât conceives that the apertures have an oblique direction through the skin, so that when the epidermis is raised by the application of a blister, the accumulated fluid, by its pressure, obliterates them.

This, and other phenomena in connexion with the cuticle, may possibly be accounted for on other grounds. Though regarded as inorganic, and as altogether wanting in those endowments indicating the properties of life, as nerves and blood-vessels; nevertheless it has relations to the subjacent tissues which are strictly vital, and the integrity of them is essential to the manifestation of its ordinary functions. The application of a blister entirely destroys these relations; and, further, which should not be lost sight of, the intense inflammation excited gives rise to the secretion of a fluid, in form and quantity, beyond the ability of the cuticle to remove. The secretion is gross both in amount and in the condition in which it occurs.

Under these circumstances, it would be unreasonable to expect, that the epidermis should be capable of furnishing an outlet for the accumulated matter. Its pores have no longer their normal relations to the membranes beneath

them ; and, moreover, the fluid which should be evacuated, does not present itself in that attenuated degree or state, which characterises the undisturbed operations of the several associated tissues,—a condition necessary to the exercise of the functions of that which is external and inorganic.

It is well known that in the dead body, the parts in which the cuticle is intact, remain moist for a considerable time, while those from which it is removed speedily become dry. The foregoing explanation applies in this case. With the cessation of the powers of life, the vital relations between the epidermis and its contiguous structures are annihilated ; and further, the moisture beneath it is not a *gradual* secretion, necessitating a passage from its activity or the state in which it exists,—and hence the imperviousness of this external covering.

Whether the perspiration be sensible or insensible, the epidermis, from its exquisite adjustment to the organs by which the secretion is produced, affords a ready issue for its escape. If sensible, the cutaneous tissues are proportionately excited. They are stimulated to inordinate activity, and the perspiration, from the rate at which it is created, forces a passage from within, outwards.

It is on these views, rather than on those to which we have alluded, that we should be disposed to explain the apparently anomalous functions of the epidermis. They are independent of its imagined elastic properties, and the oblique direction of the openings through it ; yet they account for some of the phenomena in question ; and, at the same time, point out the vital conditions which characterise the natural actions of the surface of the body.

The apertures of the skin have no constant or established magnitude. This varies with the organic requirements of the parts locally, and of the constitution at large. It is evident that the structure of the cuticle is of such a kind, as to occasion the non-detection of pores when it ceases to possess its normal vital relations to the subjacent organs, *the actions of which alone determine the capacity of its functions.*

The next membrane or substance to which we shall advert, is the *rete mucosum*, lying between the outer surface of the corion and the epidermis. Concerning its singular differences of opinion prevail among the highest anatomical authorities. The presence of it is generally admitted in the negro; but by Bichât, Chaussier, Gordon, Rudolphi, and others scarcely less distinguished, it is stated not to exist in the fair races of mankind. Bécclard, however, contends that it may be satisfactorily traced in them, and describes it as being extremely fine on the papillæ of the *cutis vera*, but less so in their intervening spaces, presenting the appearance of a net-work, but without apertures. He confesses it is difficult to convey an exact idea of its nature, and is undecided whether to regard it as a species of plastic matter, or as imperfectly organised cellular tissue. It is the seat of colour, and indisputably so in the negro; neither the blood nor injections give evidence of vessels in it, nor is it endowed with nerves. It is further observed by Bécclard, that it occurs in several regions in man, and in some of the lower animals, in the form of super-imposed layers. This fact was verified by Cruickshank, Bayham, and Gautier, both in the coloured and

the fair portions of the human race ; and by M. Dutrochet, in the skin of animals.

Two distinguished anatomical and physiological inquirers, whose remarks are always worthy of attention,* deny that the *rete mucosum* is a distinct structure. They view it as the most recently formed part of the cuticle, exhibiting depressions corresponding to the elevated papillæ of the corion, and sometimes perfect apertures, which is opposed to the opinion expressed by Bécларd. It was regarded in this light by Chaussier, and by all who consider the skin as composed of two membranes only, the *cutis vera* and the *epidermis*. Discrepancies of this kind are unavoidable from the extremely attenuated substance which is the subject of investigation.

The *corion* of the human species consists chiefly of minute dense fibres closely interwoven with each other, and the more firmly compacted the nearer they are to the epidermis. The outer surface of it is much more vascular than the inner. It possesses in considerable abundance, blood-vessels, nerves and absorbents ; and is also the seat of numerous papillæ which are supplied with nerves and blood-vessels to a greater extent than the rest of the corion. The nerves are stated to enter them denuded of their neurilema ; and some writers have endeavoured to describe the mode of their distribution, but with doubtful success.

The physiological views which it is our object to develope, have an intimate relation to the functions performed by the skin. The surface of the body is one immense channel,

* The Physiological Anatomy and Physiology of Man, by Messrs Todd and Bowman.

through which the animal system relieves itself of superfluous elements according to its necessities. The cutaneous surface secretes and throws off various substances, among which is carbonic acid. It is likewise capable of absorption. Oxygen, when in contact with it, disappears, and to this extent the functions which it exercises are analogous to those of the lungs.

The difference in the activity of the skin, in man, and in the higher orders of the mammalia, as manifested by the disengagement of refuse matters, is extraordinary. In the former, the emission of these is far greater than in the latter; yet the inference which seems naturally to follow, establishing more active cutaneous operations in man, than in this class of animals, will be shewn to be fallacious, or at least questionable.

The requirements of the body, as displayed by the secretions of the skin, vary with the internal and general structures of the animal, and the food on which it subsists. The expulsion of carbon in its various combinations, as well as of other elements with which it is accompanied, is evidence, for example, in man, of a certain degree of vital activity; but a diminution in their amount, under these forms, in animals different in constitution, *does not prove that the cutaneous surface of the latter is less active than that of the former.* The activity may necessitate the growth of particular external appendages, and the production of them may be the appropriation of substances which could not possibly escape in any other mode. The supplementary forms which they assume are the expression of the prevailing exigencies of the animal system.

The examination of this subject belongs to a subsequent part of the investigation.

Numerous experiments have been performed, in the attempt to ascertain the loss which takes place from the surface of the human body, in a given period ; as well as the variety of substances exhaled, and the proportions in which they exist. The inquiry is liable to serious sources of error, and the estimates which have been formed can only be received as an approximation to the truth. The principal ingredient, in point of quantity, is water, which forms something like $\frac{29}{100}$ ths of the whole mass. According to Lavoisier and Seguin, eight grains of perspiration were exhaled from the surface of an adult human body, per minute, or thirty-three ounces in twenty-four hours. Anselmino found, in a hundred parts of the solid matters obtained—

Osmazome, combined with common salt,	48	parts.
Lactic acid salts, with osmazome,	29	„
Animal matter, with vitriolic salts,	21	„
Calcareous salts,	2	„

We have stated that experiments to ascertain the functions of the skin, or the nature and quantity of matter excreted from it, are open to sources of fallacy. One, which is extremely obvious, does not appear to have received any consideration. Whether a part or the whole of the surface of the body be the object of examination, it is of necessity confined within an apparatus which excludes the ingress of atmospheric air, and equally the egress of substances thrown off by the skin. This is placing the animal system under circumstances very unlike those which are natural to it. The

external air is known to produce important effects on the condition of the cutaneous surface. It acts as a powerful stimulus upon it, exciting and variously modifying the actions of which it is the seat.

In these experiments this cause is altogether excluded; nor is it the only prejudicial circumstance we have to consider. Instead of fresh currents of air playing incessantly on the surface investigated, this remains in contact with the elements expelled from it, gradually accumulating in the apparatus until the end of the process. The presence of them will influence the functions of the skin, in what way or to what extent, it is difficult to calculate. The agency of the two causes combined will seriously disturb the ordinary actions of the cutaneous regions, and consequently the matters obtained cannot be received as an accurate representation of their natural effects.

These considerations have not been taken into account, nor do they seem to have occurred to the mind of the inquirer. Unfortunately, in most of the physiological experiments on living animals, the operator restricts his views, or confines his analysis, to a field far too narrow to allow him to draw just deductions from the phenomena which fall under notice.

We will give an illustration of the force of this remark, bearing on the functions of the skin, by reference to an experiment found in the most recent physiological work of the day, the writer of which is distinguished by the depth and variety of his attainments. He admits that the consequences flowing from it are difficult of explanation; but clearly, as we shall shew, from not extending his observa-

tion from the parts immediately influenced to others more remote, *but forming an inseparable portion of them.*

It being an established fact, that the transpiration from the cutaneous surface of birds and mammalia is exceedingly small in amount, it was proposed to cover the body of one of the latter with a kind of varnish, so as to obstruct entirely the process of exhalation. The animal, to the surprise of the experimenter, died in the course of a few hours.

The writer observes : “ La mort ne peut être attribuée à la suppression de la respiration cutanée, et il me paraît assez difficile de donner une explication satisfaisante de ce fait.” *

We shall shew that it is the suppression of the cutaneous respiration, and the organic results to which it directly gives rise, the nature of which had been entirely overlooked, that explains the cause of death.

Admitting that the cutaneous respiration of the mammalia is extremely small, nevertheless the quantity emitted, whatever it may be, is in perfect harmony with the requirements of the vital functions generally: and, further, it must be evident that an immense mass of vessels is distributed to the skin and its subjacent organs, carrying blood for the support and growth of hair, and is necessitated to find an outlet in this direction for the escape of its superfluous elements.

The blood-vessels, superficially seated, are channels in connexion with others of larger size, the currents of which are flowing *towards* the external regions; and the latter class of vessels have the same connexion with others of

* Cours de Physiologie, par P. Berard. Vol. iii. p. 558. Paris, 1853.

greater magnitude, and further removed from the surface of the body.

We will now proceed to examine the experiment of the physiologist, and endeavour to trace the phenomena to which it gives rise.

The moment that he suspends the actions of the vessels on the cutaneous surface, he equally affects the condition of vessels, whose office it is to supply the former with blood ; and the latter will influence others larger and more internal in the same manner ; so that at length a great portion of the circulatory system, directly and indirectly, is interrupted in its functions.

The question, in the analysis of the experiment, is not simply the condition of the cutaneous vessels obstructing transpiration; but how far and in what way the cessation of their actions is capable of influencing the whole of the sanguiferous system. It is obvious that the suspension of a class of vessels, so vast in amount as those distributed to the surface of the body, and extensively connected with others larger and more internal, consequently associated with organs exercising important functions, will so far impede the motion of blood throughout all structures as to occasion death.

The arteries and veins on the surface of the body are the termination and beginning of others, which we may readily trace, in successive steps, from without, inwards, until we reach large trunks of both vessels, the contents of which will be embarrassed ; and, at last, to such a degree, that the more vital of the internal organs will be incapable of continuing their actions. The organic effects here pointed out

and necessarily arising from the experiment, satisfactorily account for the fatal issue.

This takes place, and unexpectedly, to the physiologist. He acknowledges the difficulty of explaining it. But why? Because he did not carry his mind from the process of cutaneous respiration, to the consideration of the phenomena consequent on arresting the actions of the vessels superficially seated. He confined his observation to a single point, in place of contemplating results bounded only by the animal system.

The defect which is here alluded to, in connexion with a justly distinguished writer, may be found in most of the experiments performed on living animals. It may be shewn to exist in the greater part of those of Magendie and of Poiseuille, instituted to ascertain the force with which the blood moves in arteries and veins. They perceived an effect, but did not sufficiently investigate the causes concerned in the production of it. They lost sight of the intricate and perplexing character of the structures which they mutilated, and of important organs disturbed by their interference.

The experiment of Bérard may be rendered more clear and intelligible by the following illustration : suppose a stream of water, in motion, to be subdivided into a thousand currents : and, further, the limit at which they terminate, *to be the seat of influences which withdraw or expend a portion of them, and variously modify their movements* : we have, then, a tolerably correct representation of the condition of the blood on the cutaneous surface, and of its relations to stronger and remote streams from which it is derived. Is

it not evident, if the currents of water, at the extreme points to which they are propelled, be prevented from undergoing those changes essential to their motion, and, in fact, are substantially at rest; that the disturbance will be transmitted in a *retrograde* direction, interrupting the flow of larger streams, until at length the whole of them are brought comparatively into the same condition? This is inevitable; and analogous phenomena are produced by varnishing the cutaneous surface, the process destroying the vital actions which are natural to it. It prevents the emission of elements from the blood, and altogether arrests its motion on the external regions, the consequences of which are felt by a multitude of vessels connecting the *internal* organs with the external surface.

The experiment of Bérard has been performed by others, and the phenomena to which it gave rise, in connexion with the generation of animal heat, furnish further evidence of the correctness of the explanation here given. The importance of the subject is a sufficient apology for the additional observations we shall offer. "It would seem," remarks Professor Carpenter, "that the cutaneous respiration, small as its amount is, *promotes those molecular changes on which animal heat depends*; for it was found by M.M. Becquerel and Breschet, that when the hair of rabbits was shaved off, and a composition of glue, suet, and resin (forming a coating impermeable to the air) was applied to the whole surface, the temperature rapidly fell, notwithstanding the obstacle thus offered to evaporation of the sweat, whereby it might be supposed the temperature of the body would be considerably elevated. In the first rabbit, which had a temperature of

100° before being shaved and plastered, it had fallen to 89½° by the time the material spread over him was dry. An hour afterwards, the thermometer, placed in the same parts (the muscles of the thigh and chest) had descended to 76°. In another rabbit, prepared with more care, by the time the plaster was dry, the temperature of the body was not more than 5½° above that of the surrounding medium, which was at that time 69½°; and, in an hour after this, the animal died."

The reasoning which the able physiologist bases on these facts, shows, in our humble opinion, that he failed to appreciate the mode in which the experiment influenced the animal system, or the effects to which it gives rise. "These experiments," he remarks, "place, in a very striking point of view, the importance of the cutaneous surface as a *respiratory* organ, even in the higher animals; and they enable us to understand how, when the *aërating* power of the lungs is nearly destroyed by disease, the heat of the body is kept up to its natural standard by the action of the skin. A valuable therapeutic indication also, is derivable from the knowledge which we thus gain of the importance of the cutaneous respiration; for it leads us to perceive the desirableness of keeping the skin moist in those febrile diseases in which there is great heat and dryness of the surface, since *aëration cannot possibly take place through a dry membrane.*"*

The writer imagines that the experiment is prejudicial, from arresting the extremely limited respiration exercised

* The Principles of Human Physiology. By William B. Carpenter, M.D., F.R.S. P. 415-16.

by the skin, which, he says, "*promotes those molecular changes on which the maintenance of animal heat depends.*"

It is not clear what these molecular changes are. The animal certainly does not die from the want of that scarcely appreciable quantity of oxygen, that would otherwise have been absorbed by the skin. The cause of death is alone explicable on the physiological principles we have stated. To destroy the circulation on the cutaneous surface, in the manner related, disturbs and interrupts the motion of the blood throughout the whole of the *internal* organs.

The lungs, from the congestion induced, are no longer in a condition to oxygenate the blood—*hence the gradual reduction of the temperature of the animal.* The arterial fluid is not thus rapidly deteriorated in its properties, to a degree incapable of the continuance of life, even for a few hours, from the withdrawal of that oxygen, minute in amount, which would, in the natural state of the body, have permeated the skin; or, indeed, from any mere chemical changes of which this may be the seat, except in so far as these changes, as we have shewn, are essential to the motion of the blood throughout the animal system.*

There are few subjects possessing greater interest to the physiological inquirer than the functions of the skin; nor is the end to which they are subservient quite so clear as may probably be supposed. Matters are secreted and thrown off to the advantage of the animal economy, but in such different degrees, in animals having much in common with

* The carbonic acid thrown off by the skin, according to the researches of Schapling, is from 1-30th to 1-60th, as compared with that emitted from the lungs in the same time.

man, in their organization, and in the food on which they subsist, that there is ample room for further researches in reference to the object attained by the emission of them.

In support of this conclusion, we may quote the words of an excellent writer : " The purpose of the cutaneous exhalation has been avowed by all the highest authorities of the age in physiology not to be understood. The chemical analysis of the sweat is owned by Berzelius to throw no light on the subject. ' Water,' he says, ' is, in fact, the principal article thrown off by the skin.' I believe it to be the only essential one, and reserving the development of the point for another opportunity, I merely state it here as a general thesis, that *the business of the skin is to eliminate so much water*, and this not to reduce or regulate temperature, as is commonly said ; *but for the specific end of maintaining the current of blood returning to the heart of higher density than that which is leaving it.*"*

How far this opinion is justly founded, it is not our business, on this occasion, to examine. The writer, as he states, has not fully developed his views on the subject ; and therefore, it would scarcely be correct to criticise a doctrine which is not fully before us.

In the mammalia and birds, the cutaneous exhalation is ascertained by experiment to be remarkably limited. The fact has an important bearing on the principles which it is our intention to establish. The animal economy, as we shall subsequently shew, in proportion as it loses the necessity for

* Elements of Physiology. By Rudolphi Wagner, M.D. Translated and enriched with notes by Robert Willis, M.D. The remarks here quoted are by the translator, and the italics are likewise his.

the expulsion of **water** from the external surface of the body, **acquires** other vital exigencies in the same direction, *for the emission of superfluous elements, in structural forms and conditions which have not been suspected by the physiologist.* The internal organs, in the vigorous exercise of their functions, create external appendages in harmony with their requirements, and the growth of them is the appropriation of matters which could not otherwise be disposed of.

We come now to the consideration of the hair. Writers, in their description of its structure, and the nature of its connexion with the tissues in which it originates, generally content themselves with repeating the observations of previous inquirers; and, even those who have recently investigated the subject for themselves, have added little of importance to the facts previously possessed. Nor is it easy to imagine what new light can be thrown upon a **matter** which has at different periods been studied with attention by the first anatomists. We shall briefly state the leading facts which have been ascertained in reference to the growth and organization of this external appendage.

The hair originates in the contiguous cellular tissue of the corion. The bulb in which it is contained, is a small sac, formed of two distinct membranes. The inner one is tender, vascular, and variously coloured, and adheres closely to the root of the hair, and has been regarded as a continuation of the *rete mucosum*. The outer tunic is firmer, tougher, and white; is less vascular, and envelopes the inner one; and, at the same time, is attached to the

filamentous tissue and the under surface of the corion. The cavity of the bulb is in a great measure filled by a papilla, conoid in form, the lower portion of which is adherent to the base of the cavity, while the upper part ascends towards the orifice of the hair-follicle. The papilla is richly supplied with blood-vessels penetrating it from below, and also from between the two tunics mentioned.

The nerves and blood-vessels, with which the bulb is furnished, are extremely large, considering the smallness of the body to which they are distributed. At the neck of it, and opening into it, there are numerous sebaceous glands which are remarkably well displayed by Gurlt.

These few, simple and important facts in connexion with the hair, were satisfactorily established by the early anatomists. More refined means of investigation, and larger views of animal structures, have in later times thrown further light upon the subject, bringing more distinctly under observation the mode in which nature accomplishes particular ends.

In the attempt to convey more accurate ideas on the growth of the several parts which constitute hair, we shall borrow the language of two writers, whose knowledge, conciseness, and perspicuity, give them no ordinary claim to attention. "The hair," they observe, "grows from the bottom of the follicle, and the cells of the deepest stratum there resting on the basement membrane, are very similar to those which in other parts are transformed into scales of cuticle. A gradual enlargement occurs in these cells as they mount in the soft bulb of the hair, which, indeed, owes

its size to this circumstance. If the hair is to be coloured, the pigment grains are also here developed, for the most part, in scattered cells which may send out radiating processes; at other times, in a diffused manner, around the nucleus of the cells generally.

“The shaft is much narrower than the bulb, and is produced by the rather abrupt condensation and elongation into hard fibres of the cells, both of those which contain pigment, and those which do not.

“The human hair has a proper bark or *cortex*, formed in the following way: a single layer of the cells immediately surrounding those about to form the fibrous tissue of the shaft, are seen near the bottom of the follicle to assume an imbricated arrangement, and gradually to mount on the hair, becoming more compressed against it in their ascent, until they form upon its surface a thin transparent colourless film, in which the overlapping of the delicate cells is still exhibited by elegant and exceedingly fine sinuous cross-lines. The fibrous interior and this peculiar cortex together compose the shaft of the hair.”*

The physiological views which it is our intention to develop, in reference to the causes determining the growth and explaining the use of the hair, do not depend on the accuracy of these minute, and some of them disputed points of anatomical research. We shall have to treat of structural conditions too obvious to admit of question. In contemplating the surface of the animal system, we perceive follicular bodies and tissues displaying in their vital operations the liberal endowment of blood-vessels and of nerves.

* Messrs Todd and Bowman, *opus cit.* p. 418.

Cutaneous exhalations, as previously remarked, differ to an extraordinary extent in man and quadrupeds ; yet in some of the latter, we have evidence that the quantity of blood circulating on the surface of the body is very considerable. The nervous power distributed to it will likewise be correspondingly great.

The cutaneous actions, however, as expressed by *exhalation*, are not in the ratio of the nervous and vascular conditions of the skin. The vital processes carried on by the internal organs, necessitate, as in the human race, outlets for the escape of superfluous elements from the external regions, which are not furnished by transpiration : hence the inquiry to ascertain the means which nature provides. These we shall find to consist of hair, feathers, horns, and other analogous materials ; and, in general terms, the same in their chemical composition. Facts of this kind shew, that though animals may differ greatly in their structural conditions, they possess in common similar organic requirements with respect to the surface of the body, giving rise to the growth of appendages, the production of which is the appropriation of the superfluous elements created by the internal organs.

Although hair possesses neither nerves nor blood-vessels in its structure, the interior of it, which has been termed its medulla, has such a species of organization and relation to the bulb as to constitute it the seat of important vital actions. The colouring and other elements which it receives are subject to constant movement and change. On what ground the shaft is regarded as *inorganic*, it is difficult to imagine. In our opinion, it is beautifully and exquisitely organized. Can anything which draws its life and being from

the body, and maintains a living connexion with it, be philosophically viewed in that light? Because we do not perceive those obvious endowments and phenomena which ordinarily indicate vitality, and under circumstances which exhibit the utility of structures, we unjustly look upon the hair as inorganic, and as subservient to no particular end in the animal economy.

No part of the body is, in fact, more wonderfully organized than the hair. The means which Nature employs to produce and preserve it, are evidence of design, and what inevitably follows, utility in the appendage created, not merely as an external ornament or to serve some insignificant purpose, but as performing an important office in relation to the vital necessities of the animal system.

Bichât, who for the extent, originality, and accuracy of his views, may justly be put at the head of physiologists, irrespective of time and place, evidently looked forward to a period when the structure and functions of the hair would be matters of exact science, and not of conjecture. At the conclusion of one of his able articles on the subject, we have these words: “*Au rest tout ceci est subordonné aux expériences ultérieures qui éclairciront sans doute un jour, plus qu’elle ne l’est, la structure pileuse.*”^{*} Advances have been made in our knowledge of its organization, but unaccompanied by any progress in respect of its functions. The anatomist has marched forward, but the physiologist has not trod in his footsteps, giving additional value to the facts established.

^{*} Anatomie Générale. Système pileux. Article ii. § iii.

CHAPTER III.

THE REGIONS OF THE HUMAN BODY IN WHICH HAIR
PARTICULARLY EXISTS.

HAIR is found in greatest abundance on the head, but even here it is variable in its distribution. In some individuals it grows low and thick upon the neck: in others it is restricted to the head properly so called, becoming thin as it approaches the extreme posterior limits of it. We observe the same discrepancies in regard to the anterior region. In some the hair leaves only a narrow open space between it and the eye-brows, imparting anything but a pleasing expression to the countenance: in others the distance is considerable. These peculiarities depend on the conformation of the cranium. In some persons the forehead is low and contracted, while in others it is high and broad; and, according to these structural conditions, we commonly find modifications in the development of hair.

There are differences with respect to another part of the head. In some individuals the hair grows thick and strong almost to the root of the ear; while, in others, there is an unoccupied space from an inch to an inch and a-half in breadth.

The hair, in thickness and strength, varies greatly in different persons. It is certainly more exuberant on the head in woman than in man; and, in explanation of the fact, writers remark that nature, ever just in the distribution of her favours, is more liberal to the female in the growth of it in this situation, as a compensation for being deprived of it in other localities in which it exists in the male sex.

How far such considerations regulate the production of it, it would be vain to inquire, and equally so to speculate on the subject. If mankind would diligently investigate the works of creation—look deeper into causes and effects—they would be more felicitous in their guesses, and far happier in the interpretation of phenomena. To understand nature, we must weigh and analyse the diversity of her forms and operations. Their aspects and conditions, wisely and patiently examined, so far from embarrassing the inquirer from their variety or singularity, reciprocally shed light on the field of research, and on the circumstances modifying the appearance of external attributes.

The state of the hair on the head tends to elucidate the character of the constitution. If strong and thick, it implies considerable tone or energy of the vital powers. If, on the other hand, it is thin, soft, or silky,—prone to grow in length rather than in strength, the animal system is almost invariably weak, and the disposition of the individual is not unfrequently mild, easy, and destitute of enterprise, rarely displaying qualities which indicate force of intellect.

We may, further, remark, as the result of careful observation, that the curliness of the hair, not merely in infancy, but in after-life, is evidence of unusual constitutional vigour,

though not necessarily conjoined with a well developed muscular frame. The vital properties which throw out the external appendage thick and abundant, in harmony with the requirements of the system, are the cause, from the affluence and activity by which they are characterised, of this being not only strong, but curly. We have no hesitation in the expression of this opinion; nor will its accuracy be questioned by those who have given attention to the matter.

Of the colour of the hair, and the inferences deduced from it, bearing on the subject of the temperaments, we shall treat in a subsequent part of this inquiry. We may here observe, that the distinctions which physiologists have established, in respect of it, are in the main correct.

For example, persons of a dark or sallow complexion, who have black hair, or shades approximating to it, are, in a far greater ratio than the fair, found in the foremost ranks of the bold, daring, enterprising, and energetic of mankind. They are the creators of position, and the restless spirits which disturb the dull routine and uniformity of the thoughts, feelings, and habits of their fellow-men; less from a superiority of intellect, than from that innate mental fire which makes conception and action one. Half the world are kept in the back ground, not from the want of just notions how to improve their condition, but from thinking instead of acting. It is action, and not thought, that carries a man through the crowd struggling to advance; and, in the majority of instances, he is dark in complexion, and has a copiousness of hair similar in colour.

When the novelist describes a female remarkable for the

mildness of her disposition,—the evenness of her temper, and the suavity of her manners,—attractive from her very softness, she belongs to the fair in complexion; and if he descend to particulars, we have evidence of the fact in the light flowing hair. If, on the contrary, he studies to place before us one who is keen, penetrating, and inquisitive, determined to observe, inquire, and think for herself; and not over amiable in temper, or liable to inequalities incidental to mental endowments which constitute force of character, her hair and complexion are dark. The French epithet, *brune piquante*, conveys the same ideas.

A celebrated political writer has said, that the minority, and not the majority, is always in the right. This may possibly be the case, on subjects of which the latter are incapable of forming a correct opinion; but in matters which fall under general observation, the bulk of mankind, in the sentiments they entertain, are seldom far wrong.

In all languages we have epithets and figures of speech which embody the experience of ages, and convey pithily conclusions arrived at, not so much from a process of reasoning, as from facts which obtruded themselves on attention: and we find that the unreflecting many, in the use of them, instinctively and largely infer, from the complexion of the countenance, and the colour of the hair, particular mental qualities. Physiologists have adopted the sentiments of mankind in the distinctions they have established on this subject, as far as such facts entered into the analysis of the temperaments.

The superciliary ridge of the frontal bone is the seat of the eye-brows. Their form varies in different individuals:

in some they are strikingly arched, in others comparatively straight. They are broad and strong towards the nose, and taper to a point in the opposite direction. The hairs of which they are composed are, in some persons, thicker and stronger than those of the head. Their extreme length rarely exceeds half-an-inch.

The eye-brows are capable of two movements. They may be considerably drawn down, and, it is said, for the purpose of moderating or excluding too intense a light ; or they may be elevated, and this is stated to occur in order that greater light may be thrown upon the eye.

These considerations are, in our opinion, inadequate to account for the presence of them as evidence of design. In mankind generally, they can scarcely be regarded as either interrupting or facilitating by their change of position, the passage of light to the eye. They are ordinarily too slightly developed, and lie too close to the surface where they grow, to produce either effect to an appreciable extent. Physiologists have ascribed to them these functions from the difficulty experienced in explaining their use. From the same cause, they have argued that the hair of the head is merely to protect it from injury and to keep it warm.

If nature had intended the eye-brows for the important ends which writers have conferred upon them, we cannot help thinking, that the human race would have possessed them in such profusion, as would clearly accomplish the purposes in question. The movements to which they are subject, are the consequences of changes in the action of structures connected with the eye, as in the elevation and lowering of the eye-lids, by which the light directed to the

eye is increased or diminished. It is the eye-lids, and not the eye-brows, which efficiently perform these functions.

The eye-brows are, indeed, very unlike in the several temperaments. In the phlegmatic, and the fair, in both sexes, they are usually small; while in the bilious and irascible, or those who are distinguished by strong and violent passions, they are frequently of considerable size,—broad, long, and bushy;—meet and fill up the space immediately above the nose. They had, in a remarkable degree, this character in Elliott, the corn-law poet—a man of true genius, and in whom to think was to feel strongly. In his calmest moods, it was the volcano gathering its strength for an explosion, or the lightning slumbering in the black cloud, ominous in its movements.

They were likewise similarly formed in the illustrious Sir Walter Scott; in whom, however, there were not only rare endowments of mind, but a breadth of genial, social, and liberal feeling, that rendered him conspicuous among the irritable order to which he belonged, not less than from his matchless powers of description.

We shall find, in a subsequent part of this inquiry, that the growth of the eye-brows depends on the same organic causes as those which give rise to hair in other situations; and further, that the production of them is not in relation to the requirements of sight, but in accordance with certain *internal* necessities—vital actions which can only relieve themselves of superfluous elements by the creation of these external appendages. Many persons, from disease and other causes, lose in a great measure these supplementary organs, yet they suffer no inconvenience from the deprivation of

them. They are not sensible of their absence in the exercise of vision, which ought to be the case were the functions of the eye-brows of the importance attributed to them. We do not deny that they may to some extent act in the way supposed by physiologists. When we consider, however, that in a great part of mankind, and in the female sex especially, they are extremely limited in their development; it is difficult to conceive that the use ascribed to them was the end contemplated in their creation. They clearly originate in vital conditions, which do not appear to have a striking reference to the external requirements of sight. The degree in which they exist varies with the temperament of the individual, and in so marked a manner, that if in one case they are equal to the purpose assigned to them, they are inadequate to it in another. In all their forms and modifications of growth, they express *internal* vital necessities, and a use in relation to internal organs.

The margin of the eye-lids is also the seat of hairs, few in number, and mostly longer than those on the superciliary ridge. They are stated to protect the eye from minute bodies which float in the atmosphere. They may, in a slight degree, act in this manner. Those of the upper lid would appear better calculated than the eye-brows to moderate the light which falls upon the eye.

The most important region we have to consider, in which the hair is ordinarily abundant in the male of the human species, is the face. It is here one of the distinctive marks of the sex. It is luxuriant on each side of the face, on the chin, the upper and under lip, and on the anterior and superior part of the neck.

In the localities mentioned, it is usually much stronger and less unctuous, and at the same time more inclined to curl, than that on the head. It is less frequently the exact colour of the latter, than the hair in other parts of the body. In those who are fair, it is sometimes of a deep red, or approaching to it ; and even in those who are somewhat sallow or dark in complexion, it is occasionally of this character.

The greater strength of the hair on the face, than that of other parts of the body, and its tendency to assume a red colour, may probably appear matters of trifling moment in the consideration of it.

The greater strength and firmness of the shaft of the hair, indicates a proportionate increase in the affluence of those powers by which it is produced. The redness of it, and in the ratio of the depth of the colour, is a circumstance which likewise leads to the same conclusion. That colour should demonstrate the same fact is not extraordinary, when we consider, that, both in the animal and vegetable kingdom, it varies according to the degree of constitutional vigour possessed. The colour of the hair has not, however, been studied with attention in this point of view ; nor could it have been suggested to the mind, as a subject worthy of profound examination, unless it had been brought prominently forward in connexion with other inquiries, having reference to the causes, local and constitutional, necessitating the growth of hair. The physiologist has not entered upon these researches ; nor has he explained the use of the appendage. A writer, to whom physiology, in this country, is under deep obligations, observes, " One obvious use of hair, in the inferior animals, is to protect the body from

external cold, but except on the head, this cannot be considered as applying to the human species; nor can we easily conceive what is its object in our economy; yet it is contrary to our ideas of the nature of things to suppose, that what is so constantly found to exist should not be formed for some useful purpose.”*

Dunglison, in his admirable work on physiology, remarks, “It is difficult to assign a plausible use for the hair. That of the head has already engaged our attention; but the hair which appears on certain parts at the age of puberty and not till then, and that on the chin and upper lip of the male sex only, sets our ingenuity at defiance.”†

It is also observed by Mason Good, in treating of this subject, that the “roots or bulbs,” of hairs, “are found over the whole surface of the body, *though they only vegetate in particular parts, for which it is not easy to assign a reason.*”

We are inclined to think that the practice of cutting the beard as it grows, is not only absurd, but frequently prejudicial to the healthy condition of organs more or less interested in its development. We might with almost equal propriety shave the head, and from the same considerations, allowing us the opportunity of keeping its surface in a correct state.

The beard is the distinguishing appendage of man, and has generally been uncurbed in its growth, in those nations which have in succession been pre-eminent for valour and

* An Elementary System of Physiology. By John Bostock, M.D. 3rd edition, p. 53.

† Human Physiology. By Robley Dunglison, M.D. Vol. i. p. 106. 6th edition. Philadelphia.

loftiness of character. What connexion may exist between them we shall not attempt to trace. We have, however, an impression, that the beard, uninterrupted in its growth, is more intimately associated with the mental powers, affecting their manifestation, than may be supposed possible at first sight. It is evidence, and in a remarkable form, of masculine endowments ; and presents itself in such striking contrast with the aspect of the softer sex, that it can scarcely fail to beget, in the wearer, emotions and ideas corresponding with the causes of its production,—the virility which it expresses.

The clasp, on the breast of the brave soldier, pays back to the mind the courage that won it. It is not a useless ornament. It keeps alive, and in vigorous movement, the noblest feelings of his nature. The flowing beard will react, to some extent, in the same manner on the mental constitution.

Bichât, in discussing this subject, remarks : “ Je ne sais si, en consultant l’histoire des différens peuples qui laissent croître leur barbe, et celle des nations qui la coupent, on ne serait pas tenté de croire que la force musculaire est, jusqu’à un certain point, liée à son existence, et que cette force diminue toujours un peu lorsqu’on s’en prive habituellement. Tout le monde connaît la vigueur des anciens, celle des peuples à barbe longue, celle même de certains hommes qui, parmi nous, laissaient croître leur barbe par les lois d’une institution monacale. Sans doute beaucoup de causes peuvent faire coïncider la faiblesse avec la barbe ; mais, en aperçu general, je crois qu’on peut admettre un certain rapport entre elle et les forces.”

We have observed that the practice of cutting the beard is prejudicial to the tissues interested in its production. The difference in the expenditure of vital power, locally, between allowing it to grow, and the constant removal of it, is considerable. In the one case, the tissues of the face are greatly stimulated from the daily irritation of the skin, and from the action of the air upon its smooth surface. These causes combined facilitate the growth of the beard, but we must remember that it is at the cost of blood and nervous energy. They are, in fact, unnecessarily wasted, and often to the detriment of organs having no superfluous powers to spare.

When the beard is not interfered with it grows at a much slower rate. The parts in which it originates are in their natural, unexcited condition; consequently the external appendage is not forced somewhat like a plant in a hot-house. In its un mutilated form, it has its electric and vital relations to the superficial and subjacent tissues,—circumstances exercising no mean influence on the organs, directly and indirectly, concerned in the process of its development.

In support of this train of reasoning it is well known, that local nervous affections and diseases of the trachea, have frequently been permanently cured by allowing the beard to grow. It does not fall within the province of this inquiry, to analyse the precise mode in which these beneficial results are produced. They are mainly to be traced to the arresting of the useless waste of vital power.

The next locality in which we have to study the presence of hair, is the axilla or arm-pit. Writers have not assigned any particular reason for its growth in this situation; nor has

it attracted any attention. In the course of these researches we shall endeavour to prove, that its appearance here is in strict accordance with the organic conditions which necessitate its development in other parts of the body.

The anterior surface of the thorax is, in some men, abundantly covered with hair. The use of it in this situation has not been accounted for, except on the supposition, that it is for the purpose of keeping the chest warm. This explanation is certainly inadmissible. It would, in fact, shew that nature acts with extreme partiality in the distribution of gifts intimately connected with the well-being of the constitution. Those in whom the hair is most luxuriant, in this region, are, as a rule, *the robust and strong of mankind*, who least require the provision. In the delicate, as in those predisposed to consumption, or otherwise liable to pulmonary disease from a narrow and contracted thorax; or who are constitutionally weak, the anterior face of this cavity is free from hair or possesses only the slightest indications of it. Were it observed in profusion in these individuals; and, at the same time, found absent in those endowed with vigorous forms and powers of life, it might be urged, with great force of argument, that nature was strikingly just or peculiarly considerate in the dispensation of this particular appendage. On the chest, it is as much the effect of an organic necessity,—of the exuberant activity of the lungs, as the growth of it in every other locality expresses corresponding vital actions.

The pubis, in both sexes, is ordinarily well covered with hair, and the quantity which exists, is in the ratio of that which is common to the individual in other regions of the

body. The use of it, in this situation, is scarcely more rationally explained than its presence in other localities. It is imagined, and probably with some truth, to protect the parts from the prejudicial influence of friction. The growth of it is the result of the nervous and vital actions carried on in the tissues of the generative system, and is the appropriation of materials arising from the concentrated operations of which they are the seat.

In the male sex, hair is developed around the anus. If it has here a special utility—serves some important purpose, why is it wanting in woman? The necessity for its existence must be as urgent, in the one sex, as the other. Bichât remarks, that all external openings, in communication with the interior of the body, are furnished with hair; as the entrance to the nostrils, the ears, and the anus; and he states, that the use of it is to prevent the introduction of minute bodies into these several passages: the explanation is plausible, and, with respect to the nostrils and the ears, it may seem to contribute to this end. In the majority of persons, however, there are scarcely any perceptible hairs at the entrance of the latter organs, or in so limited a degree as not to be worthy of note.

If we admit that they exercise this function, in regard to the anus, it rests with the physiologist to explain, why the female is deprived of them. If nature gives the external appendage to the one sex, on what grounds is it withheld from the other?

From the partial distribution of it we may doubt the soundness of the views entertained concerning its use. The cause of its growth, in the several localities alluded to, we

shall subsequently examine and endeavour satisfactorily to account for. It may further be observed, that the hairs at the entrance of the nostrils and ears of the female are much fewer and finer than those of the other sex. If they have the utility, as interpreted by physiologists, why should they be given in such unequal proportions? The variableness of their development is not agreeable to the end assigned to them. If essential endowments, and destined to exercise an important office, they should be present in a condition corresponding with its implied requirements. This, however, is not the case. The growth of hair, whatever situation it occupies, is, in fact, regulated by no such principle. The presence of it, and the degree in which it is thrown out, depend altogether on constitutional and local vital causes, which differ greatly in the two sexes, and in individuals of the same sex.

Hair exists more or less over the whole surface of the body. It is less abundant on the posterior than the anterior surface of the trunk. In some men, it shews itself to a remarkable extent on the limbs, as on the anterior and posterior surface of the arms, thighs, and legs; but in the two latter more commonly on the anterior than the posterior regions.

The development of it on the limbs is facilitated by severe bodily labour,—a result that would be anticipated from a knowledge of the conditions in which it originates.

CHAPTER IV.

THE CAUSES WHICH DETERMINE THE GROWTH OF HAIR IN
PARTICULAR SITUATIONS OF THE HUMAN BODY.

THE hair, as we have remarked, is not to be considered as conferred upon the human species or on any of the orders of animal life, simply as an ornament. It is given for purposes of utility. It is this principle which characterises the works of nature. The beautiful is the creation of our own minds—the constitution of which is in exquisite relation to external objects.

We find hair in profusion in particular parts only of the human body; and, in all these, we shall discover that it is in connexion with concentrated nervous matter, and with organs, the functions of which, in certain bodily states, require the appendage as an issue for the escape of superfluous elements; the necessity of it may be established by various considerations, which have not hitherto presented themselves to the physiologist in points of view in which it is our intention to study them.

We may divide, as already observed, the organs of the animal economy into two classes, in reference to the

character of their vital contributions; the one being gross in the nature of their productions, and the other refined.

We will endeavour to render our meaning intelligible. The stomach may be taken as an example of the first class. Its operations are strictly in accordance with the requirements of the body. Its individual well-being is an effect springing out of its own labours, and the transmission of their results to other structures. The food which it receives is modified in an important degree by the actions to which it is subjected: valuable additions are made to it, and, being thus altered in its nature, it is passed forward to be further acted upon by matters poured out by other organs, each of which imparts a something to it which it did not previously possess.

The functions of the stomach are limited to the accomplishment of two effects: the secretion of gastric juice, and the changes in the position of the ingesta from the exercise of muscular contractility. It is the first to which we direct attention. This secretion is at the expense of the blood and nervous power conveyed to the organ. Both are drawn to it in greatly increased quantity to meet the exigencies of the occasion, and the loss they undergo is considerable.

The stomach has an issue for its aroused activity in the processes in which it is engaged; on the cessation of which, the blood and nervous energy flow in other directions, partly to the body generally, but especially to the viscera, which have to carry on and complete the digestive operations.

It is scarcely needful to urge, as the fact will not be questioned, that the gastric juice secreted is a measure of

the blood and nervous power expended in its production. Whatever superfluous elements arise from the processes which it promotes, they have obvious channels for their escape, and are expelled through the intestines and the kidneys. In the regions of the body to which we shall subsequently allude, useless matters can be emitted only from the cutaneous surface, and in the condition of particular structural appendages. The development of them is a necessity of the vital powers. We have evidence of the fact in the occasional, if not frequent, absence of several of the most characteristic of them, as hair, horns, and tusks; and in the modifications which they present, in man, as well as in the lower animals.

These observations are for the purpose of introducing the consideration of the brain. Its magnitude, the immense quantity of blood which is sent to it, and the energy of its faculties, aroused and in vigorous operation during almost three-fourths of the twenty-four hours, establish its claim to be regarded as a remarkable centre of vital processes. No other organ receives anything like the same amount of arterial fluid, and the office which it performs is unlike that of the stomach which has long intervals of rest. The cerebrum has no corresponding periods of repose. Its activity varies during its wakefulness, but rather in character than degree. The cessation of the predominating influence of one sense, is succeeded by the liveliness of another. Sight or hearing may be withdrawn from particular excitement, and, proportionately those regions of cerebral matter with which they are in intimate association; but, on the occurrence of this temporary change, smell or taste is

probably stimulated into vigorous operation, and, contemporaneously, certain portions of the brain.

This organ is clearly the seat of a variety of faculties implying a diversity of structural conditions; and, further, what is its peculiar characteristic, it is awakened and kept in activity through five channels, viz., the five senses. The partial interruption in the transmission of the stimuli of any one, is merely to give place to a different order of influential impressions.

The office of the brain is not to create a palpable fluid, with the exception of that, insignificant in quantity, which perhaps always exists in its ventricles. This secretion does not constitute the function of the organ, nor is it in amount commensurate with the extensive operations carried on, if the production of it were alone to be taken as a just representation of them. Leaving this fluid altogether out of consideration, the brain presents itself as a large nervous mass, extremely rich in blood, but possessing no obvious outlet for the *residue* of its wide range of vital processes; or superfluous agents which are invariably the consequence of vital action. We will endeavour to render this as intelligible and precise as the subject and our powers of illustration will allow.

The numerous organs of the body are enabled to perform their respective functions from the arterial blood transmitted to them. It is this which furnishes the different secretions, and maintains the tissues, whatever may be their structure or properties, in a condition necessary to their healthy exercise. The completion of its duties is marked by the conversion of it into venous blood, the latter wanting those

vital qualities which distinguish the constitution of the former.

It will be evident, without entering at length into the discussion of a subject, certainly fraught with no ordinary physiological interest; *that the change which the arterial fluid undergoes, both in degree and kind, will be unlike in each organ, and in the ratio of the difference of their functions.*

When we consider that the cerebrum is the seat of mental operations, and not engaged in the production of any palpable secretion; the conversion of an extraordinary amount of arterial blood into venous, will be allowed to indicate a degree of vital activity which has no parallel in the animal system; and, according to the laws which regulate the manifestation of the phenomena of animal and vegetable life, it will be accompanied with the disengagement of important elements. To determine the exact nature of these may be a difficulty, but this will not, in any degree, invalidate the fact.

The argument we are attempting to enforce is not, on a small scale, inaptly illustrated by the researches of Pouillet, a high authority in science. He performed numerous experiments on the vegetation of seeds, a condenser being connected with the soil. While the germs remained beneath the surface, no evidence of electricity was discovered; but, when they came into broad day, it was readily detected and increased in quantity with the progress of vegetation.

In this instance, we perceive that the limited action which characterises the evolution of a germ, throws off electricity in

sufficient quantity to be tested, and other principles which it was not the object of the physicist to investigate. May we not, therefore, legitimately and philosophically infer, that the brain, so abundantly supplied with blood, and the seat of vigorous vital functions, will, proportionately to the difference of its conditions, as compared with other structures, emit certain active substances? This conclusion, we contend is rational, keeping in view the distinction between the brain and other organs, whose office is to secrete a copious fluid.

The consideration which presents itself in this stage of the inquiry, is what relation exists, as cause and effect, between the actions of the brain and the production of hair? Before replying to this question, we must advert to other facts bearing directly on these researches, the understanding of which will tend to bring out more clearly the views which it is our intention to unfold.

The hair is not a singular growth. Horns, beaks, hoofs, nails, spurs, and scales, are analogous structures. The chief difference between these and hair, is that the latter remains distinct, and has its independent vascular follicle; while the bulbs of the former are agglomerated, so that but for this arrangement, what would otherwise be different hairs, as they are secreted, become connected together to form one solid body of greater or less size.*

We have alluded to the experiments of Pouillet, as shewing the disengagement of electricity under circumstances difficult to prove its existence. The manifestation of it is likewise accompanied with the escape of other elements, the

* Dunglison opus cit. vol. i., p. 106.

result of vital actions, among which, in the plant, we have oxygen, and, in the animal, carbonic acid. We may further observe, that electricity is detected in all the changes of matter; in the conversion of a solid into a liquid, or of a liquid into a solid, and of the transformation of either into any other state. The gases themselves have their electric properties. It has also been established that electricity is disengaged in muscular contractions; and, lastly, it has been traced in connexion with the operations of the cerebral tissue.

In the prosecution of these researches we shall have to treat of ponderable rather than of imponderable agents, the former of which are thrown off in different structural forms on the surface of the body.

There can be no doubt of the soundness of the physiological principles which refer the external appendages of animals to one common origin. They are admitted to be similar in their physical and vital properties by Meckel, De Blainville, Bonn, Walther, Levagna, and others.

The study of these substances is intimately connected with that of the hair. The reasoning which applies to the one will be equally applicable to the other. If we closely examine the subject, we shall find that, on whatever part of the body these particular growths appear, it is in association with a copiousness of nervous matter, energetic in its functions, which has no outlet for the residue of its vital processes, *except in the creation of external appendages*. In answer to the question, what relation, as cause and effect, exists between the activity of cerebral functions, and the hair of the head, we reply that the materials which enter into

the structure of the latter, are elements which the brain ejects as useless; consequently their escape, to this extent, is a relief to the nervous mass the seat of the mental faculties. The kidneys, the lungs, and the skin, perform a similar office in reference to the body generally.

It might be urged, that, independently of the hair, the substances, which enter into its constitution, would find a ready issue through the smooth scalp, so that such an external provision cannot be required for the end assigned to it. An objection of this kind clearly possesses no weight. The elements which escape from the skin, in the exercise of its functions, are well known and accurately determined; and certainly the materials of which the hair is formed, are such as could not find an exit, according to existing necessities, through the smooth cutaneous surface.

There is nothing unphilosophical in this train of reasoning. The growth of every organic production implies the expenditure of certain active principles; and to ascertain how far the expulsion of them may be of advantage to the animal economy, but particularly to the organs by which they are emitted, it is simply necessary to investigate their nature.

From the chemical analysis of hair, it is evident that the development of it relieves the body of a considerable quantity of carbon, as well as of several other elements, which are likewise thrown off through other channels. It was the opinion of Vauquelin and Fourcroy, two eminent chemists, that the hair, in conjunction with the other products of the skin, is capable of supplying the office of the kidneys.*

* *Healthy Skin: A Popular Treatise on the Skin.* By Erasmus Wilson, F.R.S. P. 96.

Incinerated hair is found to contain oxide of iron, a trace of oxide of manganese, sulphate, phosphate, and carbonate of lime, and a trace of silica: black hair contains most iron, light coloured hair the least; the latter, however, possesses phosphate of magnesia. Oxygen, hydrogen, nitrogen, and carbon, likewise enter into the composition of hair.* From a solution of black hair, effected by means of Pappin's digester, a black matter was deposited, which was an oil of the consistence of bitumen, together with iron and sulphur.

In a previous part of this inquiry we have stated, that water is the principal substance which is expelled from the surface of the body in the process of transpiration. It is $\frac{22}{100}$ ths of the whole of what is emitted: and further, that the action of the skin in quadrupeds and other animals is extremely limited. It is, therefore, reasonable to conclude that, in man, as well as in them, there are elements to be thrown off from the cutaneous regions, which cannot escape in the form of sensible or insensible perspiration, and fail to find an adequate outlet in the condition of carbonic acid. This is exceedingly small in quantity, not only positively, but relatively to the requirements of the animal system.

When we reflect on the amount of blood circulating on the surface of the body, and in many of the lower animals maintained for a length of time in active movement,—blood, rich in chemical elements, we can scarcely suppose that the emission of watery vapour, and a minute quantity

* Elements of Physiology. By J. Muller, M.D. Translated by William Baly, M.D. Part i., p. 390.

of carbonic acid, is a just representation of the necessities of the skin and of the system at large. Can we imagine that the arterial fluid transmitted to the cutaneous surface undergoes no other change in its conversion into venous blood, than what is indicated by these insignificant losses? Such an idea would be absurd. The disengagement of them, in such proportions, cannot possibly be the measure of the elements expelled from the skin by its active and unceasing vital operations.

We might almost, with equal reason, contend that the exhalation from the surface of the soil carries off the nutritive materials in which it abounds. We may extend the analogy. These materials find an outlet in the development of the seed which is sown. So it is with particular regions of the body, which differ in the degree of vital action by which they are characterised. Their local exigencies for the discharge of chemical elements will be in the ratio of this action. The several localities in which hair copiously grows, but very different in quantity, have their peculiar requirements for the emission of superfluous substances, and we may estimate the urgency of them by the luxuriance of the external appendage.

The carbon and other materials which have to be thrown off from the body, escape in the condition of hair and of productions similar in composition. It is in such forms only that they can find an issue.

In the attempt to account for the presence of hair on the head, we have to consider the vital actions of the cerebral organs, and the necessities they create for the emission of various substances, as carbon, sulphur, iron, manganese, and

silica, and in the ratio of the processes carried on, and of the more or less vigorous condition of the constitution.

The superfluous elements of the brain would have no adequate outlet from the smooth cutaneous surface, and of this we have evidence in the fact, that hair, in any degree of profusion, is developed exclusively in certain regions of the human body. Why do we observe it in these only? Why not over a much larger surface? The matters which enter into the constitution of the appendage exist in the blood, consequently are not confined to any locality. The reason is evident, according to the physiological principles laid down. Particular parts of the cutaneous surface represent different degrees of vital action in subjacent tissues; and hence organic necessities, *for the expulsion of useless elements, will vary with these circumstances.*

Hair appears on the entire surface of the body, but, except in certain regions, it is short, fine, and small in quantity. The presence of it to this extent is an important fact bearing directly on these views. Why does it occur in this limited form? It shews that cutaneous transpiration does not remove from the skin the whole of the materials arising from the actions of which it is the seat. Unexcited as these are, it is clear that there are elements disengaged which can find an issue only in the growth of hair.

In extending this line of argument, we perceive, in passing from the general surface of the body, to a particular region, in which vital operations are characterised by greater activity, that hair is proportionately developed. And why? Because the organic requirements of the tissues, for the emission of useless matters, are increased precisely to the

same extent. We have here cause and effect in intelligible forms. The dependence of the one upon the other is unequivocally established.

We cannot conceive on what ground the accuracy of this train of reasoning can be questioned.

The head possesses a greater affluence of hair than any other part of the body. What are the organic conditions by which it is distinguished? The brain, exquisite in structure, and one of the most active organs of the animal system, fills the capacious cavity of the cranium. Its faculties are maintained in vigorous exercise at the expense of blood and nervous power; and according to the energy with which they act, *in relation to constitutional endowments*, is the amount of useless elements to be thrown off. The quantity, necessitating an issue, is greater here than in any other locality, and as a consequence the growth of hair is proportionately more abundant.

In order to place the matter prominently and distinctly before the mind, and in a form which cannot possibly be misinterpreted, suppose we compare the vital conditions of the cranial surface with those of the thigh on which we have numerous short hairs. They have certainly little in common, in regard to the character of the vital functions which they respectively represent.

Is it not obvious that the brain is a centre of far greater vital activity than the muscular tissues, restricting the comparison to a corresponding mass of organic substances? It is difficult to compare the two in this point of view, they are so unlike in the degree of their vital operations. The difference in the nature of them we may leave altogether out of

consideration. It is an element of no particular importance in the discussion of the subject.

In contemplating these two cases, we observe that hair is developed in both in relation to the vital actions which distinguish them; and in the phenomena cause and effect are discerned in exquisite harmony.

The growth of hair on the head, as well as in other situations, is to be referred to the vital actions of the organs where it is produced; but which clearly do not give rise to the same, or, indeed, approximative results. In some persons, the appendage is thick, strong, and luxuriant; in others, it is thin, soft, and small in quantity. The explanation of these discrepancies leads to interesting physiological considerations. They are to be accounted for in accordance with two classes of causes: the one, local, belonging to the tissues with which the hair is directly and indirectly connected: the other constitutional.

With respect to the first, it requires no argument to prove that the organs composing the animal system possess degrees of vital action very unlike in different individuals. In one it is energetic, and is shown by effects which cannot be misunderstood; in another, it is languid or weak, as is seen in the nature of the mental and bodily exertions.

The activity displayed by an organ is to be traced to the condition of the nerves with which it is furnished;—to the amount of the animating principle by which they are pervaded. It is this that imparts to structures the vital properties which they variously manifest. The vigour of their functions is in the ratio of their nervous power.

These remarks on the nerves of an organ apply with

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equal force to the whole of the nervous system. The differences to which we have alluded are not local, but general; consequently have an application to the entire tissues of the body and the offices they exercise. If the nervous system, at large, is wanting in nervous energy, the digestive apparatus impresses a corresponding character on the chyle, and the blood which results is deficient in rich and stimulating qualities. Its composition varies, not only with the food on which man subsists, but with the natural tone of the organs co-operating in the accomplishment of the digestive process.

These facts, the accuracy of which will not be questioned by the physiologist, are a step in the investigation, introducing the consideration of *the causes which occasion the diversities in the growth of hair*.

In the foregoing observations we have briefly endeavoured to explain the nature of the local circumstances influencing its production. The surfaces on which it appears are not equally the seat of excited vital operations; and therefore have not the same requirements for the evolution of elements that can escape only in the form of this external appendage.

The constitutional causes imply more or less bodily vigour, though it may not be shown in obvious physical endowments; but degrees of vital energy exhibited by the internal organs.

When the actions of these are weak, the blood is proportionately wanting in stimulating elements which would have to be thrown out in supplementary structures.

If these conditions prevail, neither the animal system generally, nor the several regions of the cutaneous surface

in particular, have urgent necessities for the emission of superfluous matters. Hence, in this case, the hair of the head will be thin or soft, not thick and strong.

It is important to keep in mind throughout this inquiry, that the growth of hair, whether on the head, face, or in any other situation, expresses constitutional as well as local causes. According to the character of the former, are the ability and exigencies of the latter to create external appendages.

From these remarks it is evident, that the development of hair upon the head, is the appropriation of materials resulting from the action of the brain, the principal of which are carbon, iron, and sulphur. These occur, of course, in combination with other substances the nature and properties of which it does not concern us to investigate.

We shall attempt to explain why certain regions of the head are destitute of hair, as the forehead, and the space behind the ears.

Were it not for circumstances, probably not difficult to discover, interrupting the growth of the external appendage, this ought, according to the general physiological principles laid down, to appear on the whole of the anterior part of the cranium. We shall study to point out the causes of its smoothness.

If parts of the brain are in the vicinity of, and in connexion with external organs the exercise of which is accompanied with the liberal expenditure of nervous power; the outlets which these present for its escape, will leave a diminished amount to find an issue in the production of hair *on the cranial surface corresponding with such cerebral*

portions. This principle, important in its application, we think may be established by facts, if not altogether unexceptionable, such as, at least, merit a candid consideration.

The anterior cerebral lobes are in the immediate vicinity of the organs of sight and of smell. The optic nerve aids, in a remarkable degree, the affective and intellectual faculties; and it is more directly connected with the cerebral tissue lying backwardly, laterally, and *anteriorly*, than with that which forms the superior surface of the brain. The nerve of smell communicates with the *anterior* lobes. Of the activity of this sense it is unnecessary to speak. The magnitude of the structural apparatus which nature has given for the reception of odoriferous particles, attests the importance, and at the same time, conveys a just idea of its extensive vital operations. These are carried on at the expense of a large amount of blood and nervous power, and the maintenance of them leaves no useless elements to be emitted, promoting the growth of hair on the cranial surface of the anterior lobes;—and hence the absence of it.

That centres of vital processes, like those of sight and of smell, are capable of producing such an effect on the cranial surface within their influence, will not appear an irrational supposition; if we consider that they are outlets, and on a large scale, for the escape of matters resulting from the action of these senses; and in proportion as they are withdrawn from any part of the cerebral tissue, *in the same degree are those vital conditions diminished which give rise to the growth of hair.*

The production of this is natural to the head, and essentially springs out of certain organic requirements. The

regular absence of it, in any particular cranial region, is evidence that the corresponding cerebral substance is modified in its vital states by physiological causes, not difficult, in our opinion, accurately to define.

It is no argument, nor is it worthy of being so designated, to contend that the smoothness of the forehead adds to the beauty or expression of the head and face. We admit that it does from the laws of association; but any other conformation, if universal, would be regarded by mankind as equally appropriate and ornamental.

We may rest assured, whether the foregoing explanation be received as correct or not, that the non-appearance of hair, in the region indicated, is to be ascribed to some modification in the state of the cerebral tissue in this locality; arising either from a difference in the extent of the operations of which it is the seat; or from the existence of centres of vital action in its vicinity, modifying its functions, and not in a similar degree those of other portions of the brain.

The latter opinion is probably the correct one. We shall find it supported by numerous facts in the course of this inquiry, and particularly when we come to point out the causes of the difference between the two sexes, in reference to the discrepancies displayed by them in the growth of hair.

There is another part of the head in which this is absent, viz., immediately behind each ear. There is not only a smooth surface, mostly an inch in breadth, but the hairs are finer and less numerous for a short distance from the margin where they begin to grow. Why do they not

clothe the surface to the root of the ear? A satisfactory reason will be found in taking into consideration the extensive influence of the sense of hearing on contiguous and external tissues. The finely adjusted apparatus for the reception and transmission of auditory impressions, is in direct connexion with this smooth surface; and it is needless to urge that it is an important centre of vital action, and requires for the exercise of its functions a concentration or a liberal amount of blood and nervous energy.

The external, as well as the internal parts of the ear, are richly endowed with arteries and nerves; and it is evident that the structures to which they are appropriated are the seat of various operations, the tendency of which is to draw towards them the circulating and nervous currents; establishing, in this situation, a degree of action far greater than exists in its immediate vicinity. The power which is thus exerted so affects the superficial tissues, as to diminish their organic necessities for the development of hair. The chemical elements which they would otherwise have to expel, are in part withdrawn from them, and find an outlet in the nourishment of the ears and in the exercise of their functions.

It will scarcely admit of doubt, that every such centre, whatever be its nature, whether permanent or temporary, influences during its persistence the actions of contiguous and even remote organs. We shall offer one illustration of the fact. The hair on the pubis, during pregnancy, is well known occasionally to become thin or altogether to fall off. The phenomenon is easy of explanation on the principles advanced. The uterus, in its impregnated state, is a centre

of extraordinary vital processes. It draws to it blood and nervous power for the completion of foetal organization; and the demands which it makes leave an amount of nervous energy inadequate to maintain the growth of hair in this particular region. On the cessation of uterine activity it re-appears. And, in further illustration of the justness of this view, the absence of hair around the anus of the female may be mentioned. While it is invariably present in man, differing greatly in the degree of its growth, we have no trace of it in woman. Therefore the use which has been ascribed to it is altogether a gratuitous assumption. The cause of its non-appearance in the female is attributable to the influence of internal organs, *modifying the vital actions of contiguous or closely associated superficial tissues.*

We come now to the consideration of the cause of the presence of hair in another situation, viz.: the superciliary ridge occupied by the eye-brows. This locality has been invested with no common interest by phrenology. It is here that its advocates map out various organs.

If the actions of the brain are the occasion of the development of hair, requiring an issue for the useless elements created, it is reasonable to expect that we should find it on the superciliary ridge.

It will probably be supposed that the causes assigned for the smoothness of the forehead, viz.: the effect of neighbouring centres of vital action, should apply equally to the region of the eye-brows; consequently these ought not to exist. The parts, however, cannot justly be compared. The brain, represented by the forehead, lies apart from the external apparatus of sight and of smell, but

sufficiently near to be susceptible of a change in its condition as in the mode explained.

The superciliary ridge, on the contrary, may be said to be in immediate connexion with the apparatus of these senses; it may indeed be regarded as being within the sphere of their excited actions; so that the brain, in this particular region, instead of being influenced like that which constitutes the forehead, may have its vital conditions rather invigorated than enfeebled;—and hence the development of the eye-brows. The necessity for their production will arise, unless the carbon and other elements which compose their structure be withdrawn from the locality and otherwise disposed of. On these views we should calculate on the growth of hair on the superciliary ridge.

It must be admitted that the appearance of it in this situation is a deeply interesting fact. The phrenologist, not without profound investigation, and from observations extensive and carefully conducted, has defined along this narrow space various organs the functions of the greater part of which are active and in frequent exercise. Our own personal experience, and the attention we have given to the subject, under circumstances favourable for eliciting the manifestation of mental phenomena, have left no doubt on our mind as to the accuracy of the general principles of the science, for so we must designate it; and as far as we have been enabled to study the details of it, the impressions of its soundness have been strengthened.

If the physiological views brought forward, in reference to the causes necessitating the growth of hair, be justly founded, the invariable presence of it in the space in question,

is evidence of no mean value in support of the doctrines of Gall. If the activity of the cerebral organs is the occasion of the development of the external appendage, this clearly shows itself in the region under consideration in accordance with phrenological principles. The train of reasoning, however, by which we are guided in this inquiry, is independent of any aid derived from or coincidence with them. It rests on its own particular facts and researches; and, therefore, whatever conclusions may be drawn in respect of the one will in no degree affect the other.

The next localities in which we have to examine the growth of hair, are the eye-lids; on the margins of which we have the eye-lashes. They are results arising from the vital activity of the structures in which they originate. The eye-lids are in incessant movement during our waking moments, and from the functions they exercise, the disengagement of useless elements proportionate to the vital processes carried on is inevitable. It is from the same cause, that hair grows at the entrance of the nostrils, of the ears, and around the anus of the male.

We are aware, that at this stage of the inquiry, it will appear a questionable assumption to assert, that the eye-lashes are simply the appropriation of superfluous materials thrown off by the tissues with which they are connected. It is the method which nature adopts for getting quit of them, and the external appendage which they form, whatever locality it occupies, varies in its luxuriance with the constitutional requirements of the body.

We shall now endeavour to trace the structures and functions of the parts which give rise to the beard. The subject

offers many points of interest, and abounds in facts which corroborate, in a striking manner, the views advanced in regard to the causes determining the production of hair generally. We shall not, on this occasion, study the constitutional circumstances which modify the growth of it in the male. This will form another branch of investigation.

We shall first glance at the structures which enter into the composition of the face. The osseous foundations on which the muscles and other tissues repose, differ greatly in one important respect. The upper jaw, and its associated bones, are, in general terms, immoveable; while the lower jaw is capable of extensive action, as is displayed in articulation and mastication.

This distinction may probably appear a matter of trifling moment, in discussing the causes of the growth of hair in this particular region. It is, however, a circumstance of considerable value in relation to the inquiry, as we shall afterwards show.

The other structures, bearing on these researches, are glands, as the parotid and the submaxillary. The former lies immediately before the ear, and is the largest of this class of organs. The latter is seated under the angle of the jaw. They are abundantly supplied with nerves and blood-vessels, and are active in the secretion of their respective fluids. They make great demands on the nervous and circulatory powers. The regions they occupy are characterized by more vigorous vital operations than any other part of the face.

If we examine with attention the distribution of nerves to the face, we shall observe that the appearance of hair on its

several parts, is in strict accordance with the amount of nervous matter with which they are endowed. It is unnecessary to state that they are proportionately supplied with blood.

We will briefly analyse the nervous conditions of the face, in order to establish the justness of these observations.

The second portion of the fifth pair or the superior maxillary nerve, sends few branches to the muscles and the super-imposed tissues of the upper parts of the face. It is principally distributed to the orbit, the ethmoid and spongy bones, contributing to and enlarging the sense of smell;—to the teeth and gums : and lastly, it forms a connexion with the sympathetic nerve imparting nervous power to the carotid artery.

According to these remarks, it is clear that only a small portion of this division of the fifth pair is expended on the muscles and the superficial tissues of the upper regions of the face; nor are they the seat of any particular actions beyond those of motion, and only in a limited degree, as in the changes of the expression of the countenance, and in articulation and mastication. The parts to which we allude are almost entirely destitute of hair, and the absence of it is in perfect harmony with their structural and functional conditions.

The extent to which nerves are distributed to organs bears directly on the inquiry : the greater the amount, the more developed are the tissues as centres of vigorous action. And in the same proportion is the necessity increased for the expulsion of useless elements, which find a channel for their escape in the production of external appendages in the several regions of the body.

If we examine the *third* branch of the fifth pair, the largest of the three divisions, and the shortest within the skull, we perceive that it is chiefly expended on the lower jaw—the tongue—the salivary glands—the *muscles engaged in mastication, and the skin of the same regions*. The parts which it supplies are principally instrumental to motion and secretion. The numerous branches of this nerve are in a great measure lost in the super-imposed tissues of the bones of the face, and mainly in those which constitute its lower and lateral portions. The liberal distribution of it in these situations, implies, of course, correspondingly excited vital actions. Before pointing out the application which these facts naturally suggest, we must advert to a subject inseparably connected with these remarks, viz., the extensive motion of the lower jaw,—the means by which it is accomplished, and the power it exerts on the structures contributing to it.

The muscles directly concerned in this motion are the temporal, the masseter, and the two pterygoid. They have different origins and insertions, but the localities they occupy *are the sides of the face, and chiefly that part where the whiskers appear*.

The motion of the lower jaw, particularly in mastication, excites the salivary glands and the several muscles alluded to, as well as those interested in the expression of the countenance; and in the performance of other acts, as the movements of the lips by which food is seized and conveyed into the mouth.

These few anatomical observations are sufficient for the object in view. They establish the existence of peculiar

structural conditions at the sides of the face, and immediately above and below the angle of the jaw. We have here the parotid and submaxillary glands—centres of extensive vital operations, and greatly influenced by the muscular actions to which the parts are subject.

We have explained why certain portions of the face are destitute of hair, possessing in fact only a limited amount of nervous power; and further, that the movements of which they are the seat, are not of a character to necessitate the growth of the external appendage. The large nerves which they receive, are principally distributed to structures which have little relation to the superficial regions; and the materials, arising from the processes in which they are engaged, have other outlets for their escape.

Where is the hair most luxuriantly developed on the face? Where does it usually first appear? The answer to the latter question will furnish a satisfactory reply to the former. It first shows itself in the space immediately anterior to the ear, where it receives the name of whiskers, and on the upper lip and chin. Are not such effects in perfect agreement with the principles and reasoning pervading these researches? The lateral and contiguous regions of the face are rich in glands, nerves, blood-vessels, and strong muscles,—conditions which do not exist in an approximative degree in any other part of the face; nor is any subject to the same muscular contractions, stimulating and increasing the vital actions of the tissues within the range of their operations.

These facts will not for a moment be doubted. In the regions indicated, hair first shows itself, and on the at-

tainment of manhood, is occasionally copiously displayed in persons of vigorous constitution. Is not its appearance here in accordance with the views on which its growth is explained, depending, as we have stated, on the disengagement of elements from excited vital processes, in connexion with structures, the conditions of which, and their relations to the system at large, have been specified?

When the powers of life are weak or deficient in tone at this early period, and even subsequently, there is scarcely any hair in those situations where it is designated beard; and in the lateral regions of the face too insignificant an extent to be worthy of the name of whiskers.

To avoid misconception concerning the physiological principles advanced, further remarks are necessary in reference to particular structures of the face.

The parotid and submaxillary glands, as centres of vital action, though superficially seated, would probably only imperfectly occasion the growth of hair, unless the tissues with which they are associated *were subject to frequent and strong muscular movements*. This opinion is founded on the following considerations: the glands are engaged in the secretion of a fluid, the issue of which, through its ducts, agreeably to the demands of mastication, is a relief to their excited operations. A portion of the materials which they create has an exit into the mouth, mixing with the food, and to this extent the necessity for the development of hair may appear to be diminished. It is evident, however, that the region occupied by these glands, abounds in nerves and blood-vessels essential to and aiding the muscular contractions of the parts; and, therefore, it is a centre of extraordinary

vital energy, requiring, according to the principles laid down, the external appendage by which it is distinguished.

Before proceeding to the examination of the presence of hair in other situations, it will not be out of place to offer a few observations on the relation between the growth of it, and the condition of the animal system. When we come to treat of the temperaments we shall discuss the subject more at length.

The production of hair does not depend simply on the vital actions of the cutaneous surface. They constitute unquestionably an important part of the process. They are, however, merely the means which nature employs for the expulsion of superfluous elements. The tissues which throw out the appendage do not create the materials which enter into its composition. They are channels through which they are eliminated, *and in relation to the exigencies of the animal system*; or, in other words, they are emitted in the ratio of the quantity received by the superficial structures. If they do not exist in abundance, from the prevailing character of the vital functions, they will not need an issue in the form of beard and whiskers. These indicate an affluence of the powers of life.

The comparative absence of hair on the face, in persons of sound and vigorous constitutions, is, therefore, no objection to the justness of the physiological principles advanced. The fact only shows, that superfluous elements, essential to the development of it, are not present to an extent to necessitate its growth. The argument will apply with equal force to some of the lower animals. Those of the same species, in different parts of the world, and in the same

regions, differ greatly in regard to the luxuriance of a characteristic appendage.

Discrepancies of this kind, so far from militating against the accuracy of the views brought forward, tend in an important degree to strengthen them. Differences of climate and of food will give rise to constitutional conditions very unlike in the same species of animal, consequently in the exigency for the production of the same supplementary structures.

We have now to speak of the appearance of hair in other situations. It is found in the axilla or arm-pit of both sexes. We have in this locality three conditions which have been analysed in reference to certain regions of the face; viz., glands—a concentration of nerves, which radiate from this point in various directions; and lastly, these and their associated tissues are subject to frequent and strong muscular contractions, as in the diversified movements of the arms.

Agreeably to the principles advocated we should be led to anticipate the presence of hair in the axilla. It is a centre of remarkable vital action, towards the formation of which five spinal nerves concur; viz., the fifth, sixth, seventh, and eighth cervical nerves, and the first dorsal. They here meet and constitute the axillary plexus. The glands are likewise large and numerous. It is not needful to expatiate on the motions of the shoulder-joint, in which a mass of nerves, glands, blood-vessels, and muscles are interested. These, it is obvious, will be powerfully influenced, and, as a necessary consequence, an issue will be required for the superfluous elements created. The hair

which is thrown out is a provision which nature has furnished.

The appearance of it in this situation is under circumstances analogous to those which occasion the growth of whiskers. We perceive similar structural and physiological conditions;—and hence the supplementary appendage.

In another region of the body, viz.: the groin, it might be alleged that physiological conditions exist only slightly different from those of the axilla; yet are not accompanied by any particular development of hair. We allude to the fact as it might suggest itself to the minds of others.

The smoothness of the cutaneous surface in this region is not, however, opposed to the foregoing train of reasoning. The groin does not possess anything like the same amount of nervous matter as is present in the axilla. It is not, like the latter, an important centre for the accumulation and distribution of nervous power; and agreeably to these differences are the modifications in the growth of hair.

The locality we propose next to investigate, as affording a further illustration of the accuracy of these views, is the pubis. The supplementary appendage, in this situation, is common to both sexes: when the constitution is delicate or displays little energy, it is extremely limited in its development. It appears, at the age of puberty, and increases in thickness and length with the progress of the animal system.

The generative organs for the purpose of fulfilling the intentions of nature,—securing the propagation of the human race, are richly endowed with nervous matter, from which they derive the exquisite sensibility by which they are

characterized. They have their periods of extraordinary excitement, implying a proportionate degree of vital action in the tissues of the sexual apparatus. They possess the conditions previously described as giving rise to the growth of an external appendage; which is subject to the same changes, as in other parts of the body, from age, disease, and other causes.

We have stated that hair is developed around the anus, but in the male sex only. The absence of it in the female is not difficult of explanation; and when we come to treat of her constitution, and of the circumstances by which it is influenced, we trust we shall be able to account for the peculiarity in question.

Before bringing this branch of the subject to a close, we shall advert to the presence of hair in another region of the male sex, viz., the *anterior* surface of the chest. In some persons it is exceedingly abundant; while in others it may be considered as altogether wanting. As far as our observation extends, it is mostly connected with great activity of the enclosed organs and an ample expansion of the thorax. It rarely, if ever, shows itself in profusion in this situation, without being correspondingly copious in other parts of the body.

The parietes of the chest are subject to considerable muscular movements, as in the acts of respiration; but especially from the frequent and violent actions of the upper extremities, which rouse the nervous and circulatory powers throughout the tissues clothing the anterior surface of the thorax; consequently, according to a universal law of the animal system, chemical elements have to be emitted,

and they are thrown out in the form of hair. The degree in which this appears, is in the ratio of the vigour of the constitution or the fulness of its energies, excited in the superficial region by the muscular movements of the parts.

When the body is naturally weak or delicate, showing little hair on any region, except the head, the anterior surface of the chest is smooth. In all such instances, it is clear that there are no useless materials to be expelled from the skin; and hence the scantiness of hair in those situations in which it is abundant in others, in whom the powers of life are very different.

CHAPTER V.

THE CAUSES WHICH GIVE RISE TO A COPIOUSNESS OF
HAIR IN MAN.

WE have attempted to point out the structural and functional endowments necessitating the growth of hair in various situations, in some of which it is peculiar to man. As analogous vital conditions distinguish the organization of the female, in whom it is less generally distributed, it might be urged, and with some force, that the facts and reasoning which have been brought under consideration, do not, in the present stage of the investigation, establish the soundness of the principles they are employed to support.

To harmonize discrepancies of this kind is not the difficulty of the undertaking. They from the first suggested themselves, and a careful study of the laws regulating the operations of the animal system, enabled us to discover that the differences in question were in accordance with the predominating influence of dissimilar organs in each sex. While the two have many structures in common, exercising the same functions, they have others performing offices very unlike, and stamping more or less of their character on

every part of the human frame. To trace their agency, as exciting or variously affecting the manifestation of vital phenomena, is the task we impose on ourselves on this occasion.

In childhood, and early youth, the two sexes, in sentiment, action, and bodily conformation, closely approximate. The same games and pursuits interest, and we observe no remarkable differences in the outline of their figure which is destined to be developed in opposite directions, giving to each the attributes which fit them for the important ends of existence.

At puberty, an extraordinary change takes place. The growth and activity of organs previously dormant, gradually intrude their influence on the animal economy, and it is displayed in unmistakeable forms. The boy has reached the point from which he steps into manhood. The organs, which in him have acquired new life, are those of the generative system. There are none other which merit attention, in the endeavour to analyse the causes of the deeply interesting structural modifications which fall under observation.

The testicles enlarge, become sensitive, and secrete that peculiar fluid which is the source of remarkable constitutional effects: the hair showing itself in several regions of the face, and on the pubis. What is the occasion of these organic conditions? A new stimulus is clearly conferred upon the body; but what is its nature, or how does it act?

A satisfactory answer to the question will require a somewhat lengthened exposition of the vital powers.

The semen which is secreted, is, in our opinion, in part

absorbed and carried throughout the body, exciting and invigorating nervous matter, and in consequence imparting new energies to every tissue. In favour of this conclusion, striking facts are furnished by some of the lower animals at certain seasons. In them the aroma of the seminal fluid is readily detected, and is so strong as to taint the flesh.

Though the secretion in man is not equally obvious in its effects, it is nevertheless produced, and if it has not its natural issue, the absorption of it will occur according to the laws of the animal system. Fluids frequently accumulate in various cavities and afterwards disappear; whether from the action of absorbents, or other vessels, is a matter of no importance. If semen is collected in its receptacles, and is not emitted agreeably to the exigencies of nature, it will to some extent be taken up and conveyed into the circulating current; and at certain intervals, according to the vigour or affluence of the powers of life, the same necessity will recur.

On this subject the opinions of physiologists are divided. Some entertain the view which is here stated, regarding the secretion as gradually and imperceptibly taking place during the intervals of copulation, and lodged in the *vesiculæ seminales* as a reservoir: others contend that it is formed at the moment of the demand. The probability is that it is generated under both these conditions. The effect of dreams on the generative organs is well known; and we conceive it is more rational to ascribe the production of salacious ideas to the seminal fluid accumulated, than the secretion of it to the direct influence of the mental emotion. The ejection of it certainly depends on cerebral agency.

The facts stated with respect to some of the lower animals, in the season of their excitement, and other considerations to which we shall not advert, add no ordinary weight to the argument, contending for the absorption of the fluid, if not throughout the vigour of manhood, under particular circumstances.

The structure of the testicles is favourable to this conclusion. They are "composed of TUBULI SEMINALES, canals of great tenuity, which are everywhere copiously surrounded by blood-vessels. The tubuli anastomose with each other in loops. When unravelled from the tangled skein which they form naturally, they constitute a canal of the delicacy and diameter of a sewing thread of more than *a thousand feet in length*, the amount of secreting surface is consequently very considerable."* The marvellous capacity of the secreting apparatus, is a circumstance which not only materially facilitates the seminal secretion; but, in conjunction with the vesiculæ seminales, will aid its absorption when the occasions for its ejection are not urgent or do not present themselves.

Among the facts which may be mentioned in support of this train of reasoning, there is one which has not, as far as our reading extends, been alluded to by any writer, but which certainly bears upon the subject in hand. During a long professional career we have frequently been consulted by persons who, in early life, had acquired and practised the vicious habit of masturbation; and continued it to a period when the thoughtlessness of youth could not be pleaded as an apology.

* Rudolph Wagner, M.D. Opus cit., p. 59.

From the study of the general expression of the parties, who have indulged their propensities in this manner, we are enabled, in most instances, with unerring accuracy, to discover the vice which has been the cause of serious bodily ailments. Among the phenomena on which refined tact seizes, is one that has probably arrested the attention of no other inquirer; nor is it the most characteristic of the habit, or one that would alone by any means establish grounds for a reasonable suspicion, viz.: *the scantiness of hair on the face*. We have rarely met with a well-marked exception to the rule. When it has occurred, the individual has been endowed with more than ordinary vital resources. A striking, and almost an invariable symptom of the acquired and long persistent habit, is a downcast, blushing, or tremulous appearance of the countenance. Such, at least, frequently displays itself to the professional eye, independently of questions calculated to awaken the consciousness of the patient in reference to this matter.

The hair, in these cases, is often remarkably thin and fine, even when the constitution possesses considerable vigour, which is not inconsistent with the impoverishment of the generative organs. In what way the depraved indulgence is far more prejudicial to the animal system, than the legitimate gratification of the appetite, we shall not stop to investigate. The difference is between nature forced and nature allowed to speak for herself. In the one instance, great exhaustion of the nervous system is often the consequence, and to an extent that neither time nor circumstances correct: in the other, within certain limits, the demands which the passion creates are salutary, if not invigorating.

We have adverted to this subject, on the present occasion, from its obvious bearing on the line of argument pursued. We conceive that the reckless expenditure of this secretion, at a time when the body is developing itself,—exerting its energies for the thorough maturity of its powers,—deprives it of a genial and valuable stimulus essential to the perfection of the animal frame. Indeed, when the vice is carried to an extreme, the constitutional effects which it produces, differ comparatively little from those which are consequent on the mutilation of the organs in early life, leaving out of consideration the diversified forms of disease which the former not unfrequently causes. In the one case, the strong emotions which the sexual feeling inspires have been experienced, and to this extent the animal frame has been vivified by their agency; but this is arrested in its further beneficial progress. In the other, the emotions have not been felt, or so imperfectly as scarcely to be regarded as exercising any awakening power.

In the eunuch, we have phenomena on which there can be no cavil or dispute. In him we have a clear and decisive experiment. It leaves nothing to be desired beyond the facts which it furnishes. We perceive what nature is in her mutilated form; how far structures and functions are affected by the removal of organs the influence of which it is our object to examine.

We may philosophically infer, that whatever be the sum of the difference in the manifestation of organic conditions, between the imperfect being and one possessing the endowments of his species, is the unequivocal expression of the power which is to be ascribed to the generative system.

We have here a something which is positive in its results, and in direct relation to this inquiry.

The eunuch, from the loss of those organs which impart to the male sex the mental and physical states by which it is distinguished, approximates in form and appearance to the female. In place of strong and largely developed muscles, these are small and generally well clothed with adipose tissue, giving to the limbs a feminine roundness and smoothness. We have the entire absence of hair on the several regions of the face, where it is usually copious in man, and on the surface of the body generally, as in woman. The voice, from the arrested development of the larynx, is likewise shrill and acute.

Among the numerous structural differences which have been particularly remarked, consequent on the castration of animals, is the diminution in the thickness of the neck, and in the development of its muscles. This is strikingly the case in the ox, as compared with the vigorous and perfect bull; and likewise in the entire horse, as compared with the mutilated animal.

The few facts which are here brought under notice enable us to ascend to the study of important causes, and to trace their effects in the phenomena of life. We have argued that the testicles are the occasion of peculiar constitutional changes, and in part from the absorption of the seminal fluid. A new and powerful stimulus is introduced into the animal system, arousing and invigorating a variety of vital actions, and creating the necessity for the escape of superfluous elements, among which we have those which enter into the constitution of hair.

When this provision does not show itself, nature takes a different course in the distribution of her resources. If unequal to the production of one thing, she will ordinarily give rise to another. If the materials are not present, as they exist in the vigorous male, out of which bones, muscles, and hair are formed; or rather, if those actions are not excited by which organic substances are fashioned into these structures, she frequently gives a prominence or fulness to the adipose tissue. The secretion of fat is the expression of nature in her lazy movements. She can make this when incapable of higher duties, or of a greater range of vital functions. It is easy work and she does it.

We perceive in the eunuch, as in woman, the absence of that stimulus by which life is thrown from within, outwards, displaying a strong muscular outline, the firm flesh, the well-knit limbs, the ample chest, and the abounding activity of the organs which it contains, and the hairy appendage in those regions which stamp the vigorous attributes of manhood. We might extend the description by showing the influence of the generative system on the mental faculties, quickening and strengthening their operations.

In this stage of the inquiry, we cannot better convey, in few words, the difference between the constitutional conditions of the eunuch, and those of man in his complete development, than by the remark; that the one has less vital capital than the other, which, in strict relation to its quantity, seeks different modes of structural investment, and creates very dissimilar organic requirements, in reference to certain external provisions by which the system is relieved of superfluous agents.

There is another point of view in which the generative system is to be studied, diffusing a vivifying influence throughout the body, independently of the argument that any portion of the seminal fluid is absorbed. If this be regarded as questionable, the additional facts and reasoning we shall bring under consideration, will show in what way the conditions described, implying vigour of constitution, may, in some degree, arise from other causes.

The several parts of the animal system are intimately connected together, structurally and functionally. They may be remotely situated from each other; nevertheless, from the nature of the offices they perform, the actions of one will depend on the integrity of those of another. The relations which exist between the organs of generation and the brain, exemplify this in an interesting and striking form. The two classes of organs, wide as they are apart from each other, are in fact extensively joined through the intervention of nervous matter. The spinal cord is a great channel of communication between the two; so that, on numerous occasions, a change occurring in the condition of one, produces immediately an altered state in the other.

Whether the generative system, at puberty, first stimulates the brain, calling into existence particular ideas and emotions; or that the latter acts first upon the former, are matters not easy to decide, and unimportant to determine. They frequently and strongly affect each other at this period of life. The presence of the seminal fluid in the testicles excites to activity the cerebrum, and the feelings aroused are in harmony with the requirements of those organs. They are a powerful stimulus in relation to them; or, in other

words, the nervous energy which they call into play. Action and re-action between the two classes of organs go on, until, at length, nature, from the impetuosity of the sexual passion, and the functional results to which it has given rise, finds a legitimate issue.

We might enlarge on this subject, and variously illustrate it, but, for reasons which are obvious, we refrain from giving it that fulness or completeness of which it admits.

These facts suggest further physiological considerations in reference to the development and structural changes of the body at puberty. The action and re-action of which we have spoken, are not confined to the brain and the generative system. The genial influence they excite is transmitted through every fibre of the frame; nor is there a molecule of organic matter that is not touched by it. The circulation is accelerated, not in one kind of structures only, but wherever the vital current flows. The respiratory movements are similarly affected, in consequence of which the blood is more thoroughly oxygenated, carrying a richer stream of life to every organ. The digestive apparatus is equal to greater labours; more abundant and stimulating food is taken, and the stomach is supplied with additional nervous power to meet the augmented demands upon it.

The brain, regarding it merely in its functional relations to the body, leaving out of view the altered state of the mental faculties, is affected in an important degree by the stimulus derived from the generative system. From its aroused condition the nervous energy is secreted in greater copiousness, and in the ratio of the increase is the amount imparted to the nerves for general distribution. Between

them and the brain enlarged relations are established,—and the constantly recurring actions to which they give rise conduce to the rapid development of the animal system.

If we study the brain as the organ of thought and feeling, we have further illustrations of its agency. The sexual emotions awakened create a new external world. Nature puts on a different aspect,—fresh motives to exertion and enterprise arise; new ties, interests, and objects, captivate and stimulate the mind to activity. The larger world without is reflected upon the inner man, and every organ participates in the beneficial effects which follow.

The action and re-action between the mind and body, at this period, cannot fail to produce and transmit an improved circulating current to all tissues. It abounds in the elements of life, and in a corresponding degree will occasion the escape of them from particular regions, as those of the face, of the anterior portion of the chest, and more or less throughout the cutaneous surface, in the form of hair. The substances of which it is formed are thrown out agreeably to constitutional exigencies.

In addition to the causes here stated, accounting for remarkable differences between the male and female of the human species, there are other circumstances which greatly influence the former, viz.: *the active and laborious occupations of life*. These are too evident to need any lengthened notice. They imply a proportionate augmentation in the amount of oxygen inhaled,—a result of no ordinary interest in connexion with this inquiry. According to the increased reception of it, are the vital processes of the

animal system excited. The blood possesses in great abundance those properties essential to the vigorous development of the body. The conditions which it induces are antagonistic to the production of the adipose tissue. The oxygen combines with those matters out of which fat, under other circumstances, is secreted, and necessitates the expulsion of them. The prevailing vital actions, and the aroused muscular exertions, tend to throw the blood and nervous energy from within, outwards, giving rise to extensive cutaneous operations, and, in the same degree, to the emission of superfluous elements. These, as previously observed, find an issue in certain regions in the form of hair. Hence the greater affluence of this in the male than female of the human race.

The vital powers, in man, are largely *external* in their relations. In woman, from a difference of organization, and functions peculiar to her, they are *internal*. A much greater amount of blood and nervous energy is transmitted to the surface of the body of the male, than to that of the female; and the circulating fluid being likewise more stimulating, satisfactorily account for the copiousness of hair in man, in situations in which it is absent in woman. It shoots up in virtue of the actions which it represents, agreeably to the requirements of the animal system. The materials of which it is constituted must have an outlet, and it occurs in the shape of this external appendage.

The inquiry, on this occasion, is limited to the consideration of the human species, in reference to the power which is exercised by the generative apparatus on the animal system. Were it extended to the investigation of the lower animals,

as the mammalia and birds, numerous remarkable facts would present themselves, illustrative of the differences between the sexes, bringing into a strong light the causes in which they originate. In the further prosecution of these researches, additional evidence will be adduced in confirmation of the physiological views advocated.

We have stated that the anterior surface of the body is always much more hairy than the posterior. Comparatively few hairs are observed on the back, except such as are extremely fine. We have endeavoured to explain the presence of them on the anterior surface of the thorax, which in some men is found in considerable quantity; but have not studied the cause of their scantiness posteriorly, nor their abundance occasionally on the abdomen. The principles propounded, if worthy of the name, should be equal to the elucidation of these conditions.

It is scarcely necessary to remark, that the organs contained within the abdominal cavity are the seat of extensive vital operations. It is in them that the food undergoes its various changes preparatory to its conversion into blood. The stomach, and the smaller intestines in which they take place, during the period of their activity, are liberally furnished with blood and nervous power; and the expenditure of these in the processes in which they are engaged, keeping in mind the vigorous state of the circulating fluid, may be regarded as necessitating the discharge of chemical elements from the super-imposed tissues; and hence the frequent copiousness of hair on the abdominal surface. The presence of it, in this situation, in any considerable quantity, occurs only in the robust of the male sex, or those in whom the animal

system is rich in the materials of life, and characterized by vital actions which occasion, to a proportionate extent, the expulsion of superfluous elements, a part of which can escape only in the condition of hair. In the delicately constituted of the human race, the abdominal surface scarcely displays a trace of it, showing that the growth of it depends on certain states of the nervous and circulatory powers, and their structural arrangements in connexion with particular organs.

We may examine the subject in another point of view, and one which will probably appear to offer a more satisfactory explanation of the phenomenon. It may be urged, and with great force of reasoning, that the cutaneous tissues in this locality are excited by the subjacent actions of the abdominal viscera; consequently the hair which is thrown out is simply in accordance with the requirements of the region in question.

We cannot evade the importance of these superficial operations, or indeed treat with indifference the power they exert in the development of supplementary structures. Were we to do so, in what manner would it be possible to account for the appearance of hair in different parts of the body? It occurs only under certain organic and functional states. The localities in which it luxuriantly grows are distinguished by the concentration of nerves and blood-vessels, and vigorous vital actions; the latter, in some instances, arising from the muscular contractions to which the cutaneous tissues are subject.

If the external appendage is found only in abundance where these conditions exist, it is clear that the theory ad-

vanced is in strict agreement with facts. What further can be required for its establishment? Cause and effect are so obviously connected, that it is scarcely possible to question the accuracy of the principles which bring them prominently into view.

The abdominal surface of women is free from hairs; and when we come to treat of the female constitution and of the causes by which it is influenced, on which its characteristic endowments depend; it will not be difficult to assign sufficient reasons for the smoothness of the surface in this particular situation, as well as in other parts of the body.

We shall now endeavour to explain why the posterior surface of the trunk is in all men smooth, or displays only the finest hairs. It offers two conditions for our examination, one of which is fraught with considerable interest in reference to the present investigation. *We have muscular and nervous actions to analyse.*

The muscles of the back in the laborious pursuits of life are strongly exercised; but they do not confine the blood and nervous energy to any limited or circumscribed space. These are *diffused*, and equably, over a surface which includes not only the back, a portion of the anterior region of the chest, but likewise the upper or lower extremities according to the nature of the occupation. It is, therefore, evident that the posterior surface of the trunk has not those endowments that would lead us, on the principles laid down, to anticipate the presence of hair.

Were the actions of the muscles confined to the posterior region, supposing what is not possible, in order to convey

clearly our ideas on this subject, we should then approximate, though imperfectly, to those vital states which necessitate the growth of hair. We say imperfectly, because the muscles in this situation are not rich in nerves. What they possess are simply for muscular contractions. They are not extraordinary centres of nervous power, as exist in other parts of the body where the external appendage is luxuriant. The movements of the muscles promote an equable distribution of the blood and nervous energy; and, as already remarked, over a large surface. Hence the absence of local exigencies occasioning the development of hair.

The surface of the spine is much freer from it than any other part of the back, although the cord contained within the bony structure is the seat of extensive nervous functions: indeed, as a nervous centre, it is second only to the brain. In treating of the latter we expatiated on the causes of the growth of hair on the head. On the same principles of reasoning it might be asked: why does it not appear equally in connexion with the surface of the spinal cord? The two organs have little in common, and the difference, which is obvious, satisfactorily explains the absence of the appendage in one region, and its copiousness in the other.

The cord is a medium of communication between the cerebrum and the animal system generally. Its use is to convey motory power to various organs, and, also, to furnish a path for the transmission of impressions from without and within the body, to the sensorium. It is not like the brain, *the seat of independent faculties, each of which is an active centre in the cerebral tissue.* The numerous nerves which pass out from the spine along its entire

length, are so many channels through which the nervous energy generated or received by it, finds an outlet, in its course to the important structures which it supplies. On these views it is evident that the animating power is drawn off, and is not concentrated within the cord, as in the case of the brain, for the performance of special functions. Consequently, according to the line of argument pursued, the external surface of the spine should be exceedingly smooth.

There is one other point connected with this subject to which we must allude, viz.: the absence of hair on the palms of the hands and the soles of the feet, which are more constantly exercised than any other part of the body; and, therefore, it is natural to suppose that they would possess some structural provision, which might be regarded in the light of an outlet for superfluous chemical elements. They have two provisions analogous in their influence to that of hair, viz., the adipose tissue and the nails. In a subsequent part of this inquiry we shall find, that the deposition of fat is one of the modes which nature adopts for ridding herself of materials not wanted for carrying on the healthy processes of life. The tissue in question is principally formed of carbon, and largely so is the hair. They both indicate the existence of processes relieved by the emission of useless elements, and in this case are appropriated to the formation of nails and of fat.

Where there is the disposition to the production of the latter substance, the hair is often deficient or greatly modified in its condition. They do not express the same degree or character of vital operations. In this respect they

are very different. The constitutional and local causes which occasion the ample growth of hair, are evidence of greater activity and vigour of the animal system, than those which generate an abundance of the adipose tissue.

The nails are simply the hair in another form. The parts of which they are composed are agglutinated together, in consequence of the concentration of nervous matter in the defined line from which they arise. In a subsequent part of these researches we shall study them in connexion with other supplementary structures.

CHAPTER VI.

THE CAUSES OF THE SMOOTHNESS OF THE CUTANEOUS
SURFACE IN WOMAN.

AT puberty, woman displays in form, functions, and mental manifestations the distinguishing qualities of her sex. The breasts become prominent, giving to the bust its peculiar attractiveness and beauty; the haunches gradually enlarge, and the adipose tissue generally receives additions. The mind, likewise, undergoes a remarkable change. Fresh emotions arise, and their dominant influence is impressed upon the disposition, conduct, and character of the female. Self-importance is awakened in a way not hitherto experienced, and she studies to make it felt. Her tact and discrimination seldom slumber when interest or passion prompts: they are the instruments with which she labours, and effectually, in the accomplishment of her ends. What she wants in physical power is liberally supplied from other sources.

At the period of which we are treating, the uterus establishes its periodical secretion, which is the first evidence of its existence and activity. From this moment we have to

contemplate a new centre of vital operations, the agency of which is destined to be transmitted to every fibre of the frame.

The uterus and its appendages have a direct nervous connexion with the greater part of the body. From the abdominal portion of the trisplanchnic nerves branches are derived, which unite with each other and form six plexuses, filaments from which interlace, in the manner of net-work, the arteries passing into the substance of the organ and its associated structures. Through these nerves the womb is in intimate relation with the brain, the spinal cord, and the animal system at large.

In the uterine apparatus we have thus an important centre controlling and variously modifying the powers of life. Towards this point the nervous and circulating currents are largely directed; and the external regions to which they likewise flow, express in their condition the effects of this central action.

The breasts, and the lateral and posterior parts of the pelvis, are stimulated and developed through the agency of the uterine nerves. These have a direct influence on remote structures; but the modifications they induce in the form and expansion of them depend mainly on the qualities of the circulating fluid. This differs greatly in its constitution and distribution from that of the male. It tends more to the deposition of fat from being less oxygenated; and, from the same cause, conjoined with the feebler action of the heart, is transmitted with less force from within, outwards, and maintained in less vigorous movements in the superficial regions. It varies also, in these respects, in

different females. Scarcely in any two are its properties and circulation alike; nevertheless, its general tendency is the growth of the adipose tissue, the deposition of which imparts to woman the graces and attractiveness of her figure and the smoothness of its surface.

In analysing the organic and functional endowments of man, we have shown that, from special and general circumstances, life is evolved in salient forms and striking manifestations from within, outwards. Hence the large and well-knit muscles—the ample chest—the activity of the cutaneous surface, its copiousness of hair, and the growth of the latter in situations distinctive of masculine necessities.

In woman, the currents of life find an issue *internally*; and so imperative are the requirements in this direction, that a limited amount only is appropriated to the external regions, and we have evidence of it in phenomena which indicate the lowest degree of vital action compatible with health, viz., a predisposition to the development of the adipose tissue.

We have not in those regions excited organic processes which, according to the principles laid down, are the cause of the production of hair. There is no vigorous or redundant cutaneous activity; and, therefore, as a natural consequence, the surface generally, as compared with that of man, is smooth, and, in certain localities, particular appendages are altogether wanting which in him are designated whiskers and beard.

According to these facts, and the arguments which spring out of them, the distinction we have laboured to establish between the two sexes, tracing it to the presence of

different organs in each, and the constitutional effects which they occasion, rests on a foundation which it will not be easy to disturb.

We have, on the one hand, pointed out the causes which give rise to the growth of hair, locally as well as generally; and, on the other, have adverted to vital conditions inimical to its production. We have stated the facts impartially; nor have they in any way been tortured to suit the purposes of a preconceived hypothesis or fondly cherished theory. We are indifferent concerning either, except in so far as they may be the expression of deeply interesting truths, the value of which, in the present state of physiological science, may be very inadequately appreciated.

In treating of the several tissues which enter into the constitution of the face, in man, it was shown that they are extremely rich in nerves and blood-vessels—circumstances to which we have attached great importance, in connexion with the development of the appendage. It may be asked, as apparently militating against the accuracy of these views: why the female, possessing similar structural endowments, does not possess corresponding external manifestations? The implied objection deserves consideration, and we will meet it in a liberal spirit.

We do not regard the nerves and blood-vessels in these situations as *per se* the cause of the growth of hair, but only in so far as the excited local actions to which they are instrumental,—the muscular movements to which they are subject, and in harmony with the exigencies of the animal system, necessitate the escape of useless chemical elements, and the appropriation of them to the formation of supple-

mentary structures. If the processes carried on in the superficial tissues have no materials of this kind to dispose of, we shall not observe nor should we anticipate a copious development of hair. Thick whiskers and an ample beard are not merely indications of the vital endowments of the face, BUT OF THE CHARACTER OF THE CONSTITUTION AT LARGE. It is, in fact, only on the principles which are here stated, that the occasional absence of these appendages in man himself, is explicable. He is often wholly or comparatively destitute of them; nor are they essential to masculine attributes.

Other branches of the subject remain to be investigated which will satisfactorily elucidate these and other discrepancies. Our labours would be incomplete and certainly deficient in evidence essential to the establishment of the views brought forward, were we to content ourselves with having pointed out the causes of the broad distinction between the two sexes. The principles are capable of much wider application.

In studying the influence of the womb on the animal economy, there is one fact in connexion with it of no ordinary interest, and of practical value in relation to this inquiry, viz.: its *periodical secretion*. The regularity with which this usually occurs is well known, and the efforts made to explain its use have given rise to various conjectures, none of which are regarded as satisfactory. According to the prevailing opinion, it is a means which nature employs to maintain the viscous in a healthy state, and preserve its susceptibility to impregnation. On this point writers generally are agreed. That the secretion has a reference to the well-

being of the organ is unquestionable; and equally so, that it is generally an evidence of its sound condition.

A distinguished physiologist in treating of this subject, remarks: "We are quite ignorant of the cause of menstruation, and its periodical return. The notion of the ancients that it cleansed the body from noxious matters is evidently erroneous. The opinion, also, that its office is to relieve the uterus of the blood, which during pregnancy would nourish the embryo, is unsatisfactory, since the small quantity of blood lost in menstruation, does not correspond with the amount of nutriment which the fœtus derives from the mother. More probability attaches to the view, that the human female is preserved from great sexual excitement by the menstrual flux." *

Of late years a very different doctrine has been proposed to account for menstruation, viz.: the *ovular* theory, which ascribes the monthly discharge to the periodical excitement of the ovaria, and the consequent escape of mature ovules from the Graafian vesicles. On this view, the catamenial secretion is regarded as secondary to the ovarian phenomena,—in fact it is looked upon as the result of an imperfect attempt at the formation of the decidua.

Without altogether questioning the accuracy of some of the conclusions derived from this intricate inquiry, the theory is nevertheless too sweeping and exclusive in its character; it fails, besides, to appreciate the value of certain vital conditions connected with the process of menstruation.

It has clearly been established by Dr Ritchie, that ovules

* Elements of Physiology. By J. Muller, M.D. Translated by William Baly, M.D. Part i., vi. 1842.

are occasionally expelled in childhood, and by women at other times than the menstrual period; and, moreover, that the ovarian excitement does not always cause the ruption of the peritoneal coat and the shedding of an ovule.

The advocates of the theory urge that these are exceptions to the general rule. It is difficult to prove such to be the case. The extent of the exceptions has not been ascertained. If other inquirers, equally enterprising as Dr Ritchie, and possessing the same opportunities for this particular research, were to direct their attention to the matter, it is possible that the exceptions and the rule would be greatly modified, if they did not change places. The same zeal and labour have not been bestowed to discover the number of the former, as to exhibit the strong claims of the latter.

We are inclined to adopt one part of the ovular doctrine, viz. : that the phenomena of menstruation commence with the excitement of the ovaria; considering it the first link in the chain of aroused functions, the principal object of which is, *to relieve the animal system of superfluous elements constituting the menstrual secretion.* This, on the theory in question, is not only secondary in time, but in importance. No value is attached to the evacuation of the catamenial fluid; on the contrary, it is stated to be the effect of an imperfect attempt to form the deciduous membrane, and the periodic discharge is not in any degree studied in its physiological relations to the animal economy. Numerous facts may be adduced exposing the defects of the theory. Phenomena occur on the interruption of the uterine secretion which it is difficult to explain, adopting the view, that ovarian

excitement and the expulsion of an ovule are the great ends accomplished by menstruation.

We shall here allude to a few objections which suggest themselves : others in the course of the following investigations will be brought forward.

I. When the uterine secretion is arrested, independently of impregnation, the fluid that would be discharged, under ordinary circumstances, from the uterus, occasionally finds a vicarious issue, as by the stomach, nose, ears, or from an ulcer which may exist. In this case, there is clearly no attempt, or, if any, it is abortive, to form a deciduous membrane ; yet we have evidence of the excess of a something in the circulatory system which must have an outlet.

II. It happens, at times, under the same constitutional conditions, that the retention of the menstrual fluid, in young unmarried women, has been followed by the growth of a beard equal to that of the male sex ; and in some instances by the appearance of long hair over the greater part of the cutaneous surface. Phenomena of this kind go far to prove, that superfluous elements having no longer their natural exit, are appropriated to the formation of external supplementary structures, and in this way only can the animal system be relieved of matters that would otherwise be destructive of life.

III. When the uterus from the progress of years ceases to exercise its functions, one of two effects is frequently observed, according to the nature of the constitution,—the development of the adipose tissue or the growth of hair on the face. The foregoing explanation applies to these cases.

IV. In young women, in whom none of the foregoing

phenomena occur, we have evidence in arrested menstruation of the thoroughly unhealthy state of the blood and of the fluids generally. The former is poor from the predominance of venous properties; or in other words, from an excess of carbon, which is mainly referable to the retention of the menstrual flux, the composition of which is largely carbonaceous.*

It is acknowledged that conception occasionally takes place, when the periodical discharge has been irregular or interrupted; and in some cases antecedent to the establishment of it. From these and other facts, to which we shall presently allude, it is, therefore, not unphilosophical to infer, that the secretion has a use in relation to the animal economy at large which has not been exactly ascertained or appreciated.

On a subject which is admitted to be involved in considerable mystery, and encompassed with no trifling difficulties, we may be allowed to offer views explanatory of the function to which the secretion is subservient, suggested by the physiological principles developed; and in support of which, in a subsequent part of these researches, facts of singular interest will be advanced.

The periodical discharge is mainly for the purpose of

* The opinion of Professor Carpenter on this subject, from a careful study of the facts bearing on menstruation, is particularly worthy of notice. He observes: "Perhaps the most correct general statement on the subject would be this, that there is a periodic return of ovarian excitement, which *tends* to the maturation and extrusion of ova, though it may not always reach that point; whilst there is also a periodic turgescence of the vessels of the lining membrane of the uterus, which *tends* to the production of a decidua; but that these two periods, though usually coincident, are not necessarily so; and that either change *may* occur without the concurrence of the other." *Opus cit.*, p. 799.

facilitating the elimination of carbon from the system. It is a necessity which, at a certain season of life, arises from the organization of the female. The growth of the adipose tissue can appropriate only a portion of that which has to be emitted to preserve the well-being of the animal system, or expended on the development of external structures.

This tissue which is generally found in greater abundance in woman than in man, is to be regarded in another point of view, not simply as absorbing superfluous elements in its production, but from the nature of it,—the limited tone or energy characterizing its functions, creating feeble vital actions on the surface of the body; consequently useless materials that would, under other circumstances, have an exit from it, are thrown upon various of the internal organs, and among these, especially the uterus.

The menstrual fluid possesses no fibrine, nor is it capable of coagulation. That which is natural to health or to the normal functions of the organ, must not be confounded with the discharge occurring at times in excessive quantity from constitutional weakness or other causes.

Every organ is an active and important centre of vital operations. The womb, in its unimpregnated state, from its intimate and extensive structural and functional relations to the animal system, becomes a channel through which the latter expels a portion of its useless materials. If we analyse the conditions of this viscus, apart from its connexion with the entire body, it is difficult to imagine the necessity for a periodical secretion in reference to its own well-being. If this be doubted, we will ask: why the discharge should principally be composed of carbon? There is nothing in

either the structure or functions of the organ to lead us to anticipate that this chemical substance would form a great portion of the secretion. Were this in relation to the exigencies of the uterus alone, originating in the congestion of its tissue, should we not expect that the fluid thrown off would have the general properties of venous blood? This, however, is not the case. The menstrual flux is peculiar in its constitution; but, as already remarked, carbon very largely predominates in it.

The secretion continuing from three to six or seven days, can scarcely be regarded as harmonizing with the requirements of the organ itself. A temporary excess of blood confined to it would be corrected in less time. If, however, we consider it as a channel, in relation to the animal system, for the escape of superfluous matters, the lengthened duration of the discharge may be regarded as strictly in accordance with the wants of the body; but the amount which is lost cannot be a measure of the residue of useless elements which the operations of the organ create. The phenomenon is not rationally explicable on this supposition. And we have no hesitation in stating that the more deeply the subject is studied, the less probable will it appear that the secretion merely responds to the temporary organic demands of the uterus.

The physiological views which are here advanced may be strengthened by further considerations.

Menstruation is more copious in women who lead a luxurious and indolent life, than in those whose occupations are active. In the former it is often attended by distressing symptoms; while in the latter it is usually an affair of

trifling moment. Differences of this kind are easy of explanation on the principles advocated.

It is evident that idle and indulgent habits will produce a state of the vital powers in accordance with them. What is the nature of it? Food continues to be digested and converted into chyle, making the required additions to the circulating fluid. But under the circumstances implied, what will be the condition of the latter? From the absence of active bodily exercise, neither the heart nor arteries are aroused to energetic operations. The blood will be comparatively feeble in its motion, and the distribution of it to the cutaneous surface proportionately limited. This will not possess vigorous vital actions; consequently a diminished amount of carbonaceous and other matters will be expelled from it.

It may indeed be shown, that the blood has not those properties essential to produce a healthy state of the skin. The causes which fail to promote the ample circulation of it from within, outwards, are equally prejudicial to the thorough oxygenation of it in the lungs. It only imperfectly parts with its carbon in these organs and this on obvious grounds: the prevailing bodily inactivity lessens the introduction of oxygen, the amount in which this enters varying with the degree of muscular exercise influencing the animal system.

If the useless elements created cannot escape through one class of natural outlets, they will clearly be thrown upon others. The issue of them is indispensable to health. The uterus offers itself as one of these, *and the abundant monthly secretion is the expression of the necessities of the body.* When the occupations of the female are active, the blood

undergoes extensive chemical changes in the lungs,—changes which secure its liberal distribution throughout the cutaneous surface ; so that from this, and likewise from the lungs, carbonaceous matters are more freely eliminated than in the case of the female whose habits are indolent. The constitutional conditions explain the less copious discharge at the monthly period, and the ease with which menstruation is accomplished.

It is also an established fact, that delicate females have ordinarily the catamenia more abundant than the really vigorous of the sex. The phenomenon is explicable on the foregoing train of reasoning. The powers of life are unequal to produce those vital actions on the surface of the body and in the lungs, essential to the emission of superfluous matters commensurate with the requirements of the animal system. The retention of a portion of these from this cause, is the occasion of the uterus becoming a channel for the discharge of them. We may further observe, as bearing on this subject, that the blood may be and is frequently poor or deficient in vital properties, and with a corresponding want of tone in the vessels in which it moves, will be additional, and, at times, influential circumstances greatly increasing the menstrual flux.

It is also admitted by writers, that females with a tendency to the development of the adipose tissue, have, at the monthly period, a less discharge than those who are lean yet healthy. The result is in perfect accordance with the principles we have laid down. The production of fat is the appropriation of carbon ; and, therefore, to whatever extent the latter finds an issue in the secretion of it, a diminished quantity

will be in circulation requiring an outlet from the uterus.

A physiologist, from whose labours we have often derived instruction, in attempting to account for menstruation, on the ground of an *exuberance* of blood in the female system, and in opposition to the opinion of Freind, who ascribed it to imperfect cutaneous transpiration, remarks: “ Mais nous croyons en trouver bien plutôt la cause dans cette circonstance, que la force plastique en général, et par conséquent aussi la formation du sang, *ont beaucoup plus d'énergie chez la femme que chez l'homme.*”*

It is not easy to imagine the process of reasoning or considerations which led to this conclusion. The greater vigour of man, as compared with the woman, is unquestionable ; and if we study it in the variety of its manifestations,—in the vital actions by which it is characterized, it would certainly appear illogical to infer, that the latter had the advantage in respect of the conditions to which the writer alludes.

If we allow that an excess of blood is a cause of menstruation, or in any way creating the necessity for it, it is explicable on the views here brought forward. The female system is unequal to the expulsion of carbonaceous and other elements in the degree of the more robust sex ; and hence the retention of them during the intervals of the catamenia.

The constantly recurring discharge from an organ possessing extraordinary structural and functional relations to the body generally, has an important, obvious, and direct bearing on the inquiry the object of which is to explain the

* *Traité de Physiologie.* Par C. F. Burdach. Trans. par A. J. L. Jourdan. Vol. i. p. 287.

smoothness of the cutaneous surface in the human female, as compared with that of the male. In treating of the latter, we have shown that various causes inherent in the organization of man, and aided in the influence they exercise by his habits and pursuits, tend to establish a vigorous circulation throughout the cutaneous regions, and in consequence the emission of surplus elements which appear in the form of hair.

In the female, in the normal condition of the uterus, a very different class of phenomena present themselves. The periodical secretion gives a direction to the blood from without, inwards : and further, the functions of the organ and its associated sexual apparatus *create a PERMANENT internal centre of vital activity, the effect of which is to lessen the energy of the circulation on the surface of the body.*

In the foregoing observations we have endeavoured to prove, that the smoothness of the cutaneous surface in woman is altogether attributable to the influence exercised by the uterus on the animal economy. It affects this in two important respects : it modifies the condition and circulation of the blood, and impresses a peculiar character on the nervous system.

The functions of the organ, whether excited in connexion with pregnancy or menstruation, are carried on at the expense of blood and nervous power ; and in whatever degree these are withdrawn from other structures, a proportionately diminished amount is left for the general purposes of the body.

We may present the subject in another point of view. Independently of any such induced change in the distribu-

tion of the blood, this, from the causes which have been specified, is deficient in stimulating properties, as compared with that of the male sex. It is not rich in those chemical elements which go towards the production of hair; nor has it such vigour of circulation from the action of the heart and arteries, as to impart energy to its motion, urging it from within, outwards; consequently, the surface of the body has not those conditions essential to and necessitating the growth of this appendage.

It may probably be asked: why the uterine secretion takes place periodically? We may ask: why the desire for food, micturition, or the action of the bowels; or in fact, why the appetites distinguishing the animal creation manifest a law of periodicity? The question applies with equal pertinency to the whole of these phenomena. In each case we have evidence of a local and constitutional exigency for the acquisition or emission of something.

The periodicity of the uterine discharge and the degree in which it occurs, are regulated, in health, by the requirements of the female system. When the secretion is altogether interrupted, independently of impregnation or lactation, various, and, at times, aggravated disorders are usually the consequence. Among some of the effects frequently observed, are a discoloration of the skin, as a yellow or dirty brown tint,—a puffiness of the face, and occasionally the appearance of an increased development of the adipose tissue, and which is always unnatural in its aspect. The liver and the digestive organs generally are greatly disturbed in their functions, as is evident from the irregularity and imperfection of their actions, and the vitiated character of

the excrementitious matters thrown off from the intestines and the bladder ; and likewise from the altered secretion of the skin.

Many of the symptoms which fall under observation unequivocally indicate a redundancy of carbon in the system. We discover it in the complexion ; in the sickly expression of the adipose tissue, and in fact, *in the imperfect oxygenation of the circulating fluid*. We cannot afford space to treat at length of these structural and functional changes. Such an investigation of them, and of other morbid states, is not necessary for the general scope and aim of this inquiry.

When the blood is abstracted under these circumstances, supposing the disease induced is altogether unconnected with inflammation, the fibrine and the blood-corpuscles are found to be diminished ; and the solid residue generally is much lessened in quantity, as compared with the constitution of the healthy fluid. In other words, it is poor or deficient in vital qualities.

The constitutional disorders occurring on the interruption of menstruation, and in a variety of forms, go far, in our opinion, to establish the justness of the principles advocated in regard to its use in the animal economy. Were the secretion merely to keep the uterus in a sound state and to fit it for impregnation ; or were it a matter of secondary importance, it is not easy to conceive in what way the derangement of its functions should occasion such diversified and serious evils. On the view which is generally entertained, the vital actions of the organ, in its unimpregnated state, have simply a reference to its own well-being. Ac-

cording to prevailing notions the periodical discharge is to relieve its temporary congestion. On the occurrence of conception, the flux is arrested, but this is not followed by constitutional disturbance like the interruption of it under other circumstances. In the healthy and robust female, the vital powers are mostly invigorated during the successive stages of foetal development. The cessation of the periodical secretion for a lengthened season, is, in this case, in no degree prejudicial to the system, the cause of which is easy of explanation.

If the interruption of the uterine discharge, independently of conception and lactation, be studied, according to the principles we have laboured to unfold, it will not be difficult to account for the morbid effects which present themselves. The animal system has no longer an issue for the escape of a portion of its waste or superfluous matters ;—an issue in peculiar relation to its necessities, and indispensable to the sound organization of the human female. The stoppage of this secretion is, therefore, followed by the *accumulation of carbon and other elements in the body, varying in degree, in different individuals, according to the character of the constitution.*

Females in whom the production of carbonaceous substances is naturally limited, from the delicate structure of the frame, the weakness of the digestive organs, the small quantity of nourishing food habitually taken ; or, in other words, from the absence of those conditions which imply vigour or a fullness of life, we ordinarily observe the pasty or wax-like countenance, and generally a predominance of purely nervous symptoms. In others, possessing vital properties in

greater abundance, the cessation of the uterine function is usually followed by a very different order of morbid phenomena.

We may examine the subject under other points of view, the interpretation of which will tend to confirm the physiological principles brought forward. During lactation or the process of suckling, menstruation, as a rule, ceases. Another issue is established in the system, and of a nature which renders unnecessary the periodical secretion of the womb. The powers of life move in their activity in another direction; and the mammary tissue which they stimulate, furnishes a nutritious fluid the constituents of which are very largely *carbonaceous*.

The interruption of the uterine discharge from the influence of lactation, proves that the secretion is not essential to the structural requirements of the organ. It may be urged in objection to the argument, that at this time it is usually unsusceptible of impregnation. We admit this, as a general fact, though exceptions to it frequently occur. The want of susceptibility may, however, be otherwise accounted for. The nervous system, during lactation, has its activity excited in the direction of the mammæ. They become important vital centres, maintained at the expense of a large amount of nervous power. On the completion of the process of suckling, the nervous system re-establishes its previous relations with the womb, and this with the entire animal economy.

The susceptibility of the organ to impregnation certainly depends on the presence in it of a certain degree of nervous sensibility. The several uterine appendages solicited in the

act of coition, and co-operating in the production of conception, imply the existence of this nervous condition. When the nervous energy is withdrawn from induced vital activity towards other regions, impregnation only occasionally happens. This opinion is materially strengthened by the interesting fact, that woman is far more susceptible of impregnation the first few days subsequent to menstruation, than at any other period. We may further state, and on unquestionable evidence, that many of the sex are alone susceptible of conception within this period. Beyond it there is slight chance of a family. Is it not reasonable to suppose that immediately after the cessation of the secretion, the uterus will be in a more lively nervous state than afterwards? The secretion is clearly connected with the nervous excitement of the womb, which does not at once subside on the interruption of the discharge.

Were this the fitting occasion to adduce further proofs and illustrations of the justness of these remarks, we might advert to the extraordinary phenomena manifested by some of the lower animals at particular seasons. It is at these times only that an imperative sexual appetite exists, and obviously in connexion with an aroused nervous condition of the uterine organs.

Woman is probably the only being subject to menstruation. The fact is important and bears directly on this inquiry. It shows that the structural and functional conditions, in other animals, do not require a similar periodical discharge. Some writers, we are aware, contend that this is not strictly confined to the human species. In certain of the monkey tribe and other animals it is stated to take place. It is, however,

asserted by the highest physiological authorities, and on evidence which scarcely admits of question, that the secretion which is observed in these cases cannot with propriety be compared with that of the human female.

If the views which are here advanced be justly founded, such a secretion, in the higher classes of animals, should either exist, or some provision for the appropriation of the superfluous elements which it represents. This, we are inclined to think, is to be found in the growth of hair and other supplementary appendages. The production of them is at the expense of carbon and other associated elements, and to this extent they afford an issue for their escape.

As soon as conception takes place, the uterine discharge, with rare exceptions, is arrested. A new vital process is set up, and the carbon, which was previously periodically emitted, contributes with other matters towards the formation of the nascent being. When we consider the structural endowments of the child, at birth, the tissues which are principally developed, we have evidence that carbon has entered largely into their organization. Even the hair on the head often displays a copiousness scarcely in harmony with the immaturity of the animal system, and in our opinion from the predominance of this chemical element.

Pregnancy in a strong and healthy woman exerts a salutary and invigorating influence, and facilitates in a remarkable degree the enlargement of the body generally, but especially of the adipose tissue in particular regions. The appetite is sharpened, the powers of digestion are increased, and the additional food which is received and elaborated is expended in the production of these effects. When the female,

on the other hand, is delicate, and unequal to the liberal support of the foetus, the body loses flesh, as is evident in the attenuated features and their anxious expression ; nevertheless women so constituted have frequently large families, and are ultimately worn out by the repetition of conception and its consequences.

In treating of the causes of the growth of hair in man, we alluded to the changes occasioned by the mutilation of the organs of generation, which are singularly corroborative of the theory propounded. The removal of the ovaries, in woman, is accompanied with phenomena not less extraordinary. On the whole they are of a more striking description. After the extirpation of them the sexual appetite and menstruation cease ; the breasts, previously prominent, gradually disappear from the process of absorption ; the muscles are developed in place of the adipose tissue, *and at the same time hair frequently appears in a marked degree on the face.*

These changes are in strict accordance with the views brought forward. The womb is no longer a centre of activity, nor an *outlet* for the escape of carbonaceous and other superfluous elements. These have, therefore, to find other channels for an issue, and the result is shown in the approximation of the female figure to that of the other sex.

The matters that have to be expelled are not expended in the growth of the adipose tissue, which might be anticipated from the analogy pointed out between its uses and those of hair. The reason is obvious. The cessation of the sexual desire and of the normal functions of the womb, *creates a new order of vital actions throughout the system ;* the consequence of which is, the appropriation of the useless

elements to purposes similar to those which characterize the male of the human species.

We may offer additional illustrations in confirmation of the soundness of this reasoning. Vicat relates the case of a young woman, twenty-four years of age, who, on the stoppage of menstruation, acquired a beard an inch in length; and Vaulevier records another which fell under his observation, in whom, from the same cause, a thick beard appeared on the chin, and extremely strong hairs on the whole surface of the body, and the voice likewise assimilated to that of the male sex.*

It is unnecessary to remark, that these phenomena are explicable on the doctrines we have laboured to establish.

When we come to the consideration of the causes which modify the growth of hair, in both sexes, changes peculiar to the female, in connexion with the uterus, will be brought prominently under notice, and will be shown to display, in a striking form, the justness of the principles on which we have attempted to account for the presence, as well as the absence of the appendage, in both sexes.

The effects consequent on the removal of the ovaries, as the absorption of fat, the development of muscle, and the appearance of hair on the face, occur only in the vigorous female, in the prime of life, and have a peculiar value in connexion with the views advanced. In the other instances alluded to, in which the menstrual flux is arrested, it might be argued that the structural changes which frequently follow, *are in part due to ovarian excitement*. The extirpation of the organs in which this is seated, shows that, independently

* Reil. Archiv. t. xi. p. 225.

of any such agency, the fluid which had previously been periodically evacuated, conjoined with the cessation of the sympathetic influence of the uterus, so modifies the constitution of the blood, that the elements in which it abounds, are appropriated to the growth of tissues and of supplementary structures characteristic of the male sex.

It is not unworthy of note, that the appearance of hair on the face of woman, occasionally assuming the strength of bristles, was ascribed by Hippocrates to a deficient menstruation.*

* *Epidem.*, Lib. vi. sect. 7.

CHAPTER VII.

CAUSES OF THE DIFFERENCES AMONG MEN IN THE
PRODUCTION OF HAIR.

IN the discussion of this difficult branch of inquiry, we shall not enter into the consideration of the causes of the differences of the human family, in the several regions of the globe, in regard to the growth of hair on the head and face. We cannot afford space for comprehensive researches of this kind. Should the present labours be received in a spirit calculated to encourage further efforts in the same direction, we may probably, on some future occasion, be induced to extend the investigation and embrace a wider class of phenomena.

In treating of the beard, in man, we pointed out particular conditions necessitating its growth, which do not exist in the female. It is, however, obvious, from the differences observed among mankind, in respect of its development, that the same general causes, implying by these, in part, the generative system, give rise to a diversity of results. Some men are luxuriantly endowed with hair on the face and other parts of the body; while others display it only in

a limited degree, or in fact have nearly the smoothness of the female.

It is, therefore, clear that there are circumstances not yet examined or defined, which modify, in the male sex, the production of the supplementary appendage, the nature and influence of which can be determined only by a patient analysis of the structures and functions of the animal system.

A profusion of hair has by many been regarded as an indication of bodily strength; and certainly some of the finest specimens of the human species, commanding in stature, admirable in form, dignified in attitude, and possessing a capacious chest and a strong muscular frame, are frequently distinguished by a copiousness of it. Such instances have so often fallen under notice, that the inference arrived at seemed to be supported by a fair amount of evidence.

In confirmation of the prevailing ideas on this subject, it is, also, generally remarked, that the more delicate and feeble of the male sex,—men whose constitutions possess little tone or vigour, have rarely much hair upon the face or other regions of the body. That the quantity with which an individual is furnished is an accurate indication of strength, is, nevertheless, an opinion to be received with such qualifications as to destroy its force. Many pugilists, renowned for their strength, powers of endurance, and achievements in the ring, have displayed little of it on the face, and on the cutaneous surface generally. We speak from personal observation of the fact, though not on an extensive scale. Some few may have an abundance of it; but a comparative scantiness, if not the rule, is very frequently remarked in this class of men.

If we examine the physical conditions of persons with whom we are familiar, it is scarcely possible to perceive a satisfactory relation between the strength of the body and the growth of this supplementary appendage.

We will endeavour to trace the causes of the differences in the production of the hirsute investiture.

Persons of a dark, brown, or sallow complexion, have it unquestionably in greater copiousness than the fair, with the exception of those whose hair is red or auburn. This is a fact which will not be doubted by any one who has given a moderate degree of attention to the subject.

If we investigate the constitutional qualities of the several temperaments, and justly seize the organic peculiarities which each embodies, we shall have ample materials for elucidating this intricate department of research. It is in this way only that correct scientific views can be attained.

The first temperament which we propose briefly to study, is the *Lymphatic*. In this, at all periods of life, the adipose tissue predominates. The muscles are feebly developed, and the bodily movements are slow, heavy, or languid. The flesh is soft, and, in some cases, seems almost diaphanous. The pulse rarely shows strength. The mind is prone to meditation or wanting in energy, rather than characterized by efforts exhibiting enterprise or a restlessness of disposition. The digestive organs are mostly active, and the indulgence of the appetite, which is generally excellent, is frequently the occasion of unseemly bodily bulk. It is usual with those who display it, to wish it to be understood that they are remarkably small eaters. In some instances this is certainly true. They are, however, the excep-

tions to the rule. There may be moderation in food, but little in regard to other matters which equally influence the animal system.

Persons of this temperament, at the prime of life or later, frequently exhibit an abundance of fat or a tendency to its production. The presence of it, in undue quantity, is not, however, necessary to this kind of constitution: a just definition of the latter is to be found in the character of the vital powers, which may be shown to be deficient in vigour, as is evident in the absence of those structural and functional conditions which imply the existence of these qualities. A predominance of the adipose tissue is ordinarily to be ascribed either to a grossness of living or indolent habits.

The diseases to which persons of this temperament are subject, indicate with considerable accuracy the nature of the constitution. In childhood and youth, scrofula shows itself in various forms, attacking different glands, joints, or bones. Consumption is also one of its frequent evils. In advanced life, antecedent to old age, the maladies which arise are, to a great extent, attributable to structural changes induced in important organs from the accumulation of fat internally, obstructing or embarrassing their operations. This is not unusual in regard to the heart and kidneys, and hence the occurrence of disorganization and dropsies.

Men who are examples of this constitution seldom display much hair on any region of the body except the head. In many cases, the face is smooth, differing only slightly from that of the female. In no other combination of vital conditions is the external appendage equally wanting.

We will study the facts which are here brought forward, and weigh the conclusions which legitimately flow from them in reference to the growth of hair.

One vital quality, and from which every other arises, forcibly intrudes upon our attention, viz. : the limited activity which marks the functions of the animal system. We shall attempt to explain with what reservation this is to be received, or rather in what sense it is to be philosophically interpreted.

It has been stated that in this temperament the appetite is generally good, and the digestive organs apparently adequate to the task imposed upon them. We have no evidence of imperfection in the successive stages of the digestive process. The individual, according to the endowments of the constitution, may, and frequently does enjoy an average state of health.

Defective operations would, therefore, scarcely be ascribed to the digestive apparatus ; yet in a justly physiological point of view it is deficient in energy. It cannot possibly be otherwise.

It is necessary to advert to the considerations which have led to the adoption of this opinion. The practical importance of the subject demands it ; and the observations we shall offer will apply to all the temperaments.

Vital action is the production of phenomena of some kind. It may be the secretion, circulation, and appropriation of a fluid to the purposes of the animal economy ; or it may be the expulsion of useless matters. In either case there is the exercise of a power in connexion with a variety of structures, but inherent only in one particular tissue, viz. :—the

nervous. It is this which maintains the living machine in motion. Every condition of which this is susceptible is the manifestation of nervous power as a *cause* of the diversified effects which fall under observation. It acts not alone, but the materials subject to its operations give evidence in the changes they undergo—in the properties by which they are distinguished—of the prevailing influence of nervous matter, and of the *degree* in which this has contributed to important results. It varies in its endowments in different constitutions, and in such a way as to show, and, indeed, unequivocally to establish, that the principle which pervades it is a capital conferred in very dissimilar proportions on individuals. In some the amount is small, and we observe it in the low tone of the functions of life. We discover it in the digestion of food, in the final elaboration of it, and on its conversion into blood : the poverty of the latter is the expression of the fact. When, on the other hand, this capital is far greater, vital actions are correspondingly more vigorous both with respect to mind and body.

It is easy to explain in what way these diversities arise. A single illustration will convey our meaning. The lymphatic constitution, according to the description here given of it, is deficient in nervous energy,—in that species of capital which is the primary stimulus of the animal system. The stomach, in common with every organ, will be imperfectly supplied with it: it will do its duty, but, as we shall show, in an indifferent manner. The food which it receives will be digested; but on the completion of the process, the chyle will not display those qualities which would have resulted from precisely the same aliment, had the digestive apparatus

possessed a greater amount of nervous power. This would have produced a more copious secretion of gastric juice or richer in the elements of life. It is impossible to deny the justness of this conclusion. Effects will clearly vary with the causes in which they originate, and in this instance as in every other throughout nature.

Food is more or less nutritious according to the properties of nervous matter. The capability of the former to meet the requirements of the body, depends on the degree in which the latter has co-operated in its successive changes. Among the poor and necessitous of mankind who have to subsist on the coarsest of articles, or on such as are conceived to possess little nutrition, nature aids them in their difficulties and accomplishes her ends by simple means. She gives to the stomach, *and through the vigour of the nervous system*, an ability to labour,—to extract from the ingesta whatever is calculated to support life, and imparts to these, qualities which the digestive organs of the luxurious and pampered of society could not bestow upon them.

From the tenour of these remarks, it is evident that in considering the conditions of the animal economy, in whatever point of view they present themselves, we perceive the greater or less influence of nervous matter concerned in the production of them.

The chyle will vary in its constitution according to the innate activity of the organs by which it is produced. Each imparts a something, and the aggregate of the individual contributions forms an important part of the nourishing fluid. This, on its conversion into blood, reflects, if we may be allowed the expression, not simply the matters derived

from the food, but the influence of the viscera in the several stages of digestion. The gastric juice will, in one case, be more stimulating and abundant than in another, and equally so the bile;—effects which will, in the same degree, modify the state of the blood. The substances which enter into its composition will differ in their proportions and vital power agreeably to these circumstances; consequently, if the contributions of the viscera be defective, either in their nature or quantity, vigorous organic operations will not be excited; *nor will copious superfluous elements be expelled from the cutaneous surface.* This, in accordance with the principles pervading the inquiry, will be only scantily furnished with hair.

The subject may be examined in another point of view. Suppose it be contended that the blood is not wanting in stimulating qualities,—a fact which is, however, indisputable; but that the tissues to which it is transmitted are unable from an insufficiency of nervous energy, to excite actions instrumental to the growth of the external appendage. Both conditions invariably co-exist. The presence of the one necessarily implies that of the other. And why? The phenomena which distinguish a temperament are mainly due to the endowments of the nervous system. This varies in different constitutions in the amount of the animating principle possessed by it, and equally so the character of the powers of life.

The accuracy of this train of reasoning is strengthened and illustrated by numerous facts, in addition to those to which reference has already been made. From organic effects we may often interpret the nature of the causes in

which they originate. Persons of the lymphatic temperament, when suffering from acute inflammation, are well known to be easily depressed by active depletory measures, as, for example, venesection; *and the blood abstracted is admitted to be deficient in fibrine*,—a predominance of which is evidence of strength or tone of constitution. The circulating fluid, even when the system is inordinately excited by disease, is comparatively poor, as is shown by the slight crust formed on its coagulation; and likewise by the large proportion of serum in which it floats. The withdrawal of blood in moderate quantity usually makes a strong impression on the body. Severe purging produces a similar result, and the patient recovers slowly from disease,—effects establishing the correctness of these views.

It may further be observed, in confirmation of the truth of these remarks, that persons of this temperament are much more liable to subacute than acute inflammation. Scrofula, phthisis, internal congestion, and structural changes, as a consequence, are frequent occurrences. In support of the same line of argument is the prominence of the adipose tissue or a tendency to its development.

The physiological principles explanatory of the growth of hair would certainly not lead us to calculate on a copiousness of it under these circumstances. There are not the constitutional, and hence not the local exigencies for its production. To be thrown out in abundance there must be correspondingly superfluous elements requiring an outlet from the surface of the body. If these are not created by the excited functions of life, the external appendage will be altogether or comparatively absent.

From the preceding observations it may probably be supposed, that the condition which peculiarly distinguishes the temperament, is the deposition of fat in unusual quantity. This inference, however, would be fallacious. In many persons there is a tendency to it from its relatively large development in constitutions of this kind; nevertheless we have numerous examples in which the body is slight and spare of flesh, and remarkable for the smoothness of the face and of the cutaneous surface generally. The greater part of them are fair in complexion, and have light or light brown hair. The proportion whose complexion and hair are dark, is small.

In connexion with this temperament we have noticed one fact which has an important bearing on the inquiry, viz. : the absence of symptoms indicating a bilious disposition or displaying a redundancy of bile. The liver may be and is frequently disordered; but the derangement is rarely accompanied with phenomena which express an undue activity of the hepatic functions. The viscus is often subject to congestion, which is mostly to be ascribed to an opposite vital condition,—a deficiency of energy in its operations.

From the lengthened investigations into which we have entered concerning the growth of hair, we conceive that a copiousness of bile is an influential cause of the development of it. Should this be found correct, the admitted variable-ness of the biliary secretion, in respect of its nature and quantity, in different individuals, will tend to throw considerable light on this novel and interesting branch of research.

The doctrine would appear to receive support from the experiments of Schwann, in which the bile in eighteen dogs

was made to escape externally through a fistulous opening in connexion with the gall-bladder. Ten of the dogs died immediately from the operation. Of the remaining eight, six subsequently died, and two recovered. The former lived from seven to sixty-four days. Among the morbid effects observed, consequent on the operation, *was the falling off of the hair.*

It will not be denied by those who have at all studied this subject, that persons who are fair, (excluding, as has been stated, those who have red or auburn hair,) have generally the cutaneous surface comparatively smooth; or have only a limited amount of the supplementary appendage. At the same time they may be endowed with a capacious chest, a strong muscular frame, and robust health. It would therefore be illogical to infer, that the degree in which hair is thrown out is a just indication of the physical powers of the body. The two often co-exist, and it is natural that they should according to the principles explanatory of the vital conditions on which both depend. There are, however, far too many striking exceptions for either to be regarded as a measure of the other.

We have examined with attention one class of individuals, in which there are admirable specimens of muscular development and bodily strength, viz., *navies*, as they are commonly designated; and among them have observed many with little hair upon the face; the greater part of these were, however, fair in complexion.

As such instances abound, it would be absurd to argue that the blood does not possess substantial nourishing and stimulating qualities. The animal system gives evidence to

the contrary. Nevertheless its chemical composition differs greatly in each temperament. It may be healthy in relation to the prevailing states of the animal economy; yet deficient in materials necessitating the growth of a particular appendage, *such not being required as a means or channel for their escape*. We must, also, further remark, that in all cases, in proportion as the circulating fluid is wanting in elements which give rise to excited vital actions, the nervous system is invariably languid or conspicuously low in energy. The association of the two, in the affluence of their powers, is essential to a profuse development of the supplementary structures: it does not, however, occur in the lymphatic constitution,—hence the scantiness of hair on the cutaneous surface generally.

In the further prosecution of this inquiry, the principles which are here brought forward will be illustrated and strengthened by numerous facts.

The next temperament of which we shall treat, is the *Muscular*. This presents itself under very different physical conditions. We shall confine our observations to two species which are common and easy of description, viz.: the lean muscular frame with no waste flesh; and a muscular predominance with a tendency to the development of the adipose tissue. Neither is remarkable for a copiousness of hair.

In the investigation of the several temperaments, the object is to seize on the salient structural and vital conditions which distinguish them; this can be accomplished only by defining clearly the phenomena which each exhibits, apart from their frequent blending or admixture with each other. The muscular constitution, for example, whether belonging to

the one or other species under consideration, is studied on the present occasion in reference to the largeness and strength of the muscles, and occurring in those who are more or less fair in complexion; or at least such as show no particular activity of the hepatic functions. Persons of this description form an exceedingly numerous class in this country; and are much less abundantly endowed with hair on the several regions of the body, than those in whom the liver displays considerable vital energy.

In the contemplation of the muscular temperament, under either of the forms alluded to, we perceive very different conditions from those which characterize the lymphatic. In the purely muscular, the movements of the limbs are active and strong. The powers of bodily endurance are great. The animal system is liable to few diseases, and those of which it is susceptible are mostly acute, whether nervous or inflammatory in their nature. If the complexion is fair, the external appendage on the face and other regions of the body is generally small in quantity: if, on the other hand, it is sallow, and the hair black, or dark brown, it is certainly found in far greater luxuriance.

This species of the muscular temperament is more rarely met with than any other structural endowment of the body. The *athlete* of the ancients were examples of it; and it is found in perfection in modern pugilists, wrestlers, and runners.

The muscular constitution, with a predisposition to obesity, is extremely common in this country; and the combination in the same marked degree does not occur in any other part of the world. The climate, the occupations which are followed, and particularly the habits of the people, prone to

sensual enjoyment, and possessing the means which minister to it, are favourable to its production. Many of the *navies* are illustrations of this form of temperament. The majority, however, belong to the other muscular species. The severe physical exertions they undergo, nevertheless, fail to correct the not unfrequent tendency to the deposition of fat. Their habits satisfactorily explain its presence. They ordinarily live substantially, and indulge freely in malt liquor, which is exceedingly influential in the development of it. The same remarks apply, with equal force, to individuals in the different classes of society. The liberal gratification of the appetite, in a comprehensive sense, is the rule rather than the exception. Hence the large unwieldy bodies,—men grossly fat at an early period of life.

Persons of this description, if fair in complexion, seldom exhibit a great abundance of hair upon the face. If, on the contrary, the complexion is sallow, it is observed in greater profusion; and is unquestionably evidence of an important difference in the state of the biliary secretion. This is either more stimulating in its properties, or poured out in greater copiousness; and, therefore, according to the views propounded, corresponding necessities exist for the emission of chemical elements in the form of the external appendage.

The next temperament to which we shall advert is the *Nervous*. By this is not to be understood, which is too generally the case, a morbid or irritable state of the nerves; or a susceptibility to impressions bordering on disease. Phenomena of this kind do not belong exclusively to any temperament. By the nervous constitution, we mean a predominance in the development of the nervous system

relatively to the rest of the animal structures. In those who are illustrations of it, we rarely perceive the capacious chest—ample lungs and heart, creating and distributing a strong and full current of blood throughout the body. Nor do the liver and the digestive apparatus arrest our notice by the activity of their functions, as displayed in their frequent derangement from an excess of bile or other disorders, or in the secretion of fat.

Persons of this constitution are lean, active, and lively in their movements, restless and energetic in what they undertake. They are frequently of a dry, hard, and unfeeling disposition: seldom troubled by a large and generous soul suggesting noble and disinterested deeds; or awakening emotions which carry man out of himself into the wide circle of humanity. The fluids and solids are never in excess. The face is seldom endowed with a copiousness of hair. The quantity is usually extremely small.

This fact is not unimportant in the present stage of the inquiry. In the lymphatic system, in which the fluids are copious, we observe a deficiency in the growth of hair, which was ascribed to a low or feeble state of the vital powers, and the consequent absence of chemical elements requiring an external outlet. In the nervous constitution, the functions of life, on the contrary, are active; yet, with few exceptions, the supplementary structures are only slightly greater in degree.

Here we have the two extreme states of the animal economy, and in neither is hair in profusion. It is more abundant in the nervous than in the purely lymphatic temperament. The activity of the nervous system is, therefore,

only one condition essential to its production : the luxuriance of it implies other endowments.

These facts, the correctness of which will scarcely be doubted, are particularly worthy of consideration in reference to the development of hair. It is clear that a copiousness of the circulating fluids, unaccompanied by the vigorous actions of nervous matter, is inadequate to the creation of it in affluent or imposing forms; and equally so the excited operations of the same nervous matter, unaided in the manifestation of its influence by the stimulating qualities of the blood.

We now enter on the analysis of the *Bilious* temperament, distinguished by a greater variety of structural combinations and vital phenomena, than any of the preceding. The body may be extremely or only partially muscular. It may be disposed, and frequently is with the advance of years, to the accretion of fat, or this may be altogether absent.

This species of constitution has been treated of at considerable length by physiologists, but we are inclined to think not happily, or with that precision or accuracy which just and comprehensive views of the animal system demand. In the description of it we have generally more fine writing than sound logical reasoning.

Men who have ruled the destinies of the world are seized upon as examples of it; and certainly, in many cases, independently of data satisfactorily elucidating their organization. According to the opinions entertained, we cannot trace inordinate ambition, a strong will, marvellous perseverance in the accomplishment of an object, but the individual must be an exquisite illustration of the constitution in question.

This is philosophy losing itself in the regions of imagination.

There is certainly some truth in the description of it; but what is genuine and indisputable is distorted by exaggeration. We shall examine its structural endowments. It is stated to be characterized by a superabundance of bile,—an excess of secretion nearly allied to disease, which is not a just view of it. It expresses a functional condition of the liver not necessary to the definition of the temperament;—an extreme which is often due to indulgence in stimulants, intemperance in diet, or mental perturbations.

Effects springing out of excesses must not be confounded with the normal condition of organs. We admit that the bile is more abundant in this than in any other association of bodily structures; or in other words, that the liver gives evidence of greater activity. The fluid which it furnishes imparts to the countenance its sallow complexion, and to the hair its deep black or approximative tints. The phenomena, however, do not establish the presence of superfluous bile in relation to the legitimate requirements of the animal system. In many persons, who are specimens of the temperament, symptoms indicating this are only occasionally observed; nevertheless, in this constitution, whatever may be the habits of the individual, on the occurrence of trivial causes of functional derangement, morbid indications present themselves which are to be traced to the predominance of the hepatic secretion. This is betrayed in the suddenly induced sallowness of the countenance beyond what is usual; and in the appearance of the tongue. In fact, during the progress of severe disease, whether fevers, inflammation, or

other affections, it is not difficult to detect the natural ascendancy of the liver in the phenomena which fall under notice.

In the bilious constitution the abdominal and thoracic organs are said to be largely developed,—the flesh firm,—the muscles prominent, and the movements of the body strong and active ; the mind remarkable for its energy, daring, and indefatigable perseverance. Physical and mental endowments of this kind are not uncommon ; and they are imagined, but erroneously, to be essential to a correct definition of the temperament, which, however, mainly rests on an accurate appreciation of the activity of the liver and of the nervous system generally ;—conditions which are associated with very different structural forms and mental phenomena. They are often found in connexion with an ordinary capacity of the chest, with muscles by no means prominent, and with powers of mind of a commonplace order. It must, however, be admitted, that persons of this temperament are frequently of a restless, excitable, and active disposition.

According to these investigations, and the simplest principles of physiology, it is evident that the composition of the blood will vary, in some degree, in individuals possessing a similar constitution, and to a considerable extent in those who are examples of the several temperaments. While in each it may have the same chemical elements, these will clearly be combined in very different proportions ; and hence the important modification in the properties of the circulating fluid, and proportionate diversities in the growth of hair.

It may be difficult to assign a satisfactory reason why bile should occasion the production of particular supplementary organs, which only appear in a conspicuous form when the liver exercises a dominant influence. The changes it effects in the process of digestion, and in the constitution of the fluid destined to become blood, show that the secretion is fraught with peculiar and extraordinary properties. If in one degree in which it is poured out, it imparts to the circulating current matters essential to its healthy state, in relation to one class of organic conditions; why should it not in another, modify to the same extent the qualities of the vital stream, rendering it more stimulating to the tissues, and creating structural necessities in harmony with its composition?

The bile is indisputably an important stimulus to the functions of life. It would seem to exert a remarkable influence on nervous matter, the naturally abundant secretion of it being generally accompanied with striking nervous phenomena. Persons who are admirable examples of this temperament, are often excitable and not unfrequently irascible. They exhibit more than ordinary force of mind. They are inflexible in temper and resolute in what they undertake. The countenance, from its complexion and other adjuncts, is susceptible of the most determined expression.

The everyday observations of mankind confirm the truth of these remarks. If a deep, designing, villanous character has to be displayed on the stage, the audience would feel something wanting to complete the portrait, were the representative to have a smooth face, and to be fair in complexion and hair. And why? Because such features would

not accord with their experience. The epithets employed in most languages to designate an individual of this description, prove how strong and prevailing are the ideas on the subject.

We have stated that the bile has a powerful influence on the nervous system. It must not, however, be understood that the activity of the latter is, in a great measure, to be ascribed to it. We conceive that the excited functions of the liver itself *mainly depend on the vigorous endowments of nervous matter*: and further, that this, in the variable qualities by which it is distinguished, is the foundation of a great proportion of the constitutional diversities of mankind. We are not insensible of the value of other and accompanying structural conformations, as the greater or less development of organs engaged in the production and distribution of the blood; nevertheless, how widely soever these may differ in their capacity, the degree of activity which marks their operations is to be traced to the predominating properties of the nervous system.

It is in the bilious temperament that the hair is observed in considerable copiousness. Whether the body be spare of flesh or inclined to corpulency, if the complexion be sallow or dark, it is only occasionally imperfectly developed. We have not the smooth cutaneous surface so common in the lymphatic and other constitutions when the skin is fair. The facts which are here stated are familiar to every one who has at all studied the subject.

We sometimes meet with individuals whose hair is dark and yet their complexion is comparatively light. They are usually slender in figure, delicate or far from being robust.

In these the face is generally smooth, and they certainly do not display those conditions of the hepatic system, either in health or when suffering from disease, which would induce us to regard them as examples of the constitution under consideration. In this the liver and digestive apparatus are obviously vigorous in their operations. The blood which they create abounds in nourishing and stimulating properties, and we discover them on the abstraction of it in acute inflammatory affections. The buffy coat is thick and cupped, and the serum is small in quantity as compared with the coagulated mass. The circulating fluid, rich in chemical elements, conjoined with the activity of the nervous tissue, necessitates the escape of superfluous matters from the cutaneous surface in the form of hair. This is never thrown out in its affluence except under these circumstances. Local and constitutional requirements must be urgent to produce it.

Persons of this temperament, and the best examples of it, frequently become corpulent towards or after the prime of life ; so that we have subsequently a large development of the adipose tissue combined with the muscular. The prominence of the former is chiefly owing to the indulgence of the appetite, diminished bodily exertion, or a proneness to luxurious ease. The digestive functions continue active, and a portion of the vital materials produced goes towards the growth of the body.

It is necessary to advert to what may be considered exceptions to the force of the foregoing train of reasoning. We have no wish to keep out of sight facts which may appear to militate against the views advocated. We have

remarked in speaking of persons who are fair, that when the hair is red, reddish or auburn, it is often found in profusion on the face and other cutaneous regions ; and those who display it are frequently endowed with a capacious and well-formed chest and active abdominal viscera,—conditions indicating vigorous vital powers. The hair is likewise strong, which is rarely the case when it is light, whatever may be the temperament.

The structural and functional states of the body do not differ greatly in those who have red, from those who have black or dark coloured hair. Those who possess the former, are, however, less inclined to corpulency with the advance of years. It is stated that red hair contains a greater proportion of sulphur than that of any other colour. How far this contributes to the production of the redness must be left to future investigations to determine.

Red must not be confounded with yellow hair. The two are very dissimilar in their strength and copiousness. Yellow hair is almost invariably soft, and is never found in abundance on the face, or on any region of the body with the exception of the head.

We shall now endeavour to condense within a brief space, the conclusions at which we have arrived on this branch of the inquiry.

I. In examining the lymphatic temperament we observed, that the organization and functions by which it is characterized, and the diseases to which it is subject, at different periods of life, are evidence of its limited vital activity. The blood is deficient in stimulating properties, and the nervous system is equally wanting in nervous power. Neither local

nor constitutional operations give rise to a surplus of elements which have to be appropriated to the growth of hair; consequently this is generally sparingly developed. We have no hesitation in the expression of this opinion. We are thoroughly satisfied of its truth. We have long studied with attention the human constitution and the physiological differences which it presents, in relation to the growth of the external appendage in question. It is clear that the luxuriance, deficiency and absence of it are in strict agreement with the views pervading these researches.

In the consideration of them it is essential to keep in mind, that the temperaments are frequently *mixed*,—one running into another, creating vital phenomena difficult of classification, and in the same degree modifying external organic endowments.

II. We next proceeded to analyse the two kinds of the muscular temperament. The lean muscular frame for purposes of strength, agility, and sustained exertion, is the most perfect of the several constitutional conditions and the least liable to disease. Pugilists are admirable specimens of it.

Persons of this temperament are seldom remarkable for genius or mental capacity. It does not furnish the illustrious in the arts, sciences, or literature. One remarkable exception, however, occurs to the mind.* In him the muscular and intellectual powers were singularly combined. His form, action, and expression of countenance, in every species of mental effort, displayed in a high degree the association of these qualities.

* Professor Wilson, the Author of the *Noctes Ambrosianæ*.

We must not, however, leave it to be inferred that a large development of the muscular system necessarily implies the absence of high mental powers. It may be, and is frequently unfavourable to the thorough cultivation of them. Nature prompts to intellectual and bodily pursuits from a variety of causes. Where she gives the strong athletic frame, and all the adjuncts of rare health, she bestows constitutional qualities which instinctively seek for their gratification in out of door occupations. In following these they have their fitting employment. None other would be strictly in harmony with their wants. To confine the possessors of them to the severe labours of the closet, not by fits of brief duration or with long intervals of rest, but during the greater part of the day,—a condition imperative to intellectual pre-eminence,—would be to enchain the fresh-caught eagle: Nature designed both for the bright sun, the invigorating breeze, and the freedom of unfettered space, and in the enjoyment of these they act in accordance with her laws.

How often bodily infirmity or weakness of the animal system, in connexion with genius, contributes, and in no mean degree, to the unfolding of its powers and the delicacy of its taste! The inability to engage in the bustling affairs of the world, creates time which would otherwise not exist for the improvement of the mind and the acquisition of knowledge. How many of the exquisite touches in the compositions of Pope are due to the influence of the causes specified! The study was his home from necessity, and the results of it are the grounds of his immortality.

Looking upon Wilson through the medium of these views,

it is no great effort of imagination to discover in his writings the facile and lively play of the muscular system. They are full to overflowing with hilarity, life, and vigour. They bear upon them, in the happiest of his moods, the impress and fragrance of external nature: and with equal propriety the same observations might be extended to Burns.

When genius is lodged in the strong or well-knit body it seems to borrow from it a masculine power, an energy and freedom of action, which it is in vain to trace in connexion with very inferior organic endowments. In the latter we may have the fastidious refinement of a Rogers;—the polished smoothness and elegance of a Montgomery; and the airy lightness and sparkling brilliancy of a Moore, but few of the qualities which display force and robustness of intellect. To draw out and impart to this its highest powers, the individual must have physical conditions bringing it into contact with circumstances congenial to it and essential to its development.

In the muscular temperament there is no redundancy of fluids. The blood is rich in fibrine and oxygenated properties, but is only moderate in quantity. The pulse is strong, but does not indicate any particular fulness. The hair on the face, in the purely muscular constitution, is only occasionally copious; but in the degree in which it is thrown out it is next to the bilious temperament.

It is not uninteresting to remark, in connexion with these inquiries, that the pugilist, from his habits and other causes, undergoes an extraordinary change in his structural conformation. The training which prepares him for the ring, occupying several months, enforces regular and severe exer-

cise, and restricts the diet to beef and biscuits principally, to the exclusion of succulent vegetables. The abundant oxygen which he inspires from his daily exertions, and the limited carbonaceous materials on which it has to act in the blood conveyed to the lungs, are peculiarly favourable to the expansion of the muscular tissue, and the absorption of redundant fat.

When the contest is over, the inactivity, and the thorough indulgence of the appetite which succeed, will frequently, in the course of a month, increase the weight of the body from two to three stones. Fat is readily and largely formed. The ingesta are beyond what the animal system can dispose of in the production of healthy and stimulating blood. This is now charged with *carbon*, and its only issue, at this time, is in the growth of the adipose tissue; which from having previously been reduced to its lowest state, acquires, if we may be allowed the expression, a keen appetency for the appropriation of materials to its own purpose.

Pugilists when they retire from the ring ordinarily become extremely corpulent; so that at two periods of life we observe very different structural conditions.

III. The muscular temperament, accompanied with an amount of fat which imparts a roundness and largeness to the limbs, and with the more or less prominent abdomen, is exceedingly common in this country. Numerous examples of it occur in the easy and affluent classes of society, and among the more independent and intemperate of the artisans. It mainly springs out of the habits and circumstances of the individuals. It is occasionally unquestionably hereditary; but even in this case, the tendency to the deposition of fat was

originally owing to the influence of the same causes. We have no hesitation in stating that in the ratio of its secretion, showing itself at a somewhat early period of life, is the less appearance of hair on the face and the body generally. If the complexion is fair it will be extremely small in quantity.

From these observations it is evident that the degree in which the external appendage is thrown out, is not a just measure of the physical endowments of the frame. Many who display it in great luxuriance, are slight in figure and in no way remarkable for strength. The growth of it depends on the activity of the liver, and to some extent on that of the abdominal viscera in relation to the rest of the vital functions. Superfluous chemical elements are produced, and the nervous system, energetic in its operations, disposes of them in the form of hair on the several regions of the body.

IV. The nervous temperament, it was observed, expresses a relatively large development or marked activity of the nervous system, and is seldom accompanied with a profusion of hair upon the face. Persons belonging to it are mostly spare of flesh, active, and capable of considerable bodily exertion. They very rarely exhibit symptoms indicating an excess of bile. The fluids generally are small in amount.

V. The bilious temperament, the last to which we have adverted, pointing out its structural and functional peculiarities, is that in which the external appendage is found in its greatest affluence. The activity of the liver and its associated organs is its distinguishing condition, and is often

conjoined with the capacious chest and vigorous respiratory movements. It is the liver, however, which determines the character of the constitution, in connexion with the naturally excited functions of the nervous system.

It is not necessary to a correct definition of the temperament, that the chest shall be particularly developed. In many instances this is clearly not the case; yet with the sallow complexion, the face is thickly clothed with hair,—evidence that the liver and the nervous system are extremely active; consequently the degree in which the appendage is evolved out is in harmony with their requirements. The sallow complexion, occurring in persons slight in figure or otherwise *delicately* formed, is never accompanied with much hair upon the face. The softness and general aspect of the flesh show a low state of vitality; and symptoms are altogether absent which establish the truly bilious constitution.

From the investigation of the several temperaments embodying very different organic endowments, it will scarcely be doubted that those who possess the external appendage in the greatest profusion, are characterized by the activity of the liver and nervous system. The blood created is fraught with abundant materials which stimulate and invigorate the vital functions generally; and the excited cutaneous actions to which they give rise relieve themselves by the production of hair: and the manner in which this manifests itself under all circumstances, *is in the ratio of the local and constitutional necessities which exist for the escape of superfluous elements.*

In the further prosecution of this inquiry the views ad-

vanced will be variously illustrated and materially strengthened. The study of many of the lower animals, and particularly the changes occurring in their clothing, at certain seasons, and at different periods of life, will afford abundant and important facts in confirmation of them.

CHAPTER VIII.

CAUSES OF THE ABUNDANT GROWTH OF HAIR IN QUADRUPEDES
AND QUADRUMANA.

IN the preceding researches the object has been to ascertain the nature of the circumstances which determine the growth of hair in the human species. We have laboured to prove that the degree in which it is thrown out on the cutaneous surface, depends, in conjunction with excited local actions, on the amount of superfluous chemical elements which the animal system has to dispose of.

If the principles we have studied to establish rest on a sound foundation, they should be susceptible of a far wider application. Nature throughout her works acts not by partial but general laws. The justness of this remark requires no argument to enforce it. Illustrations of it abound in the animal and vegetable creation, and each equally teems with obvious and apt examples.

While man possesses hair in particular localities only, in many of the lower animals it covers in extraordinary profusion the whole surface of the body. Great as the discrepancy is, it simply expresses a modification of the general

causes by which the appendage is developed in accordance with a difference of organization.

The copiousness of it, in the one case, and its absence in the other, except in certain regions, is in relation to the necessities of the animal system, originating in a difference of internal structures and functions, in the conformation of the body, and in the nature of the food adapted to these organic diversities. The circulation of the blood, and the distribution of nervous power will vary according to these conditions ; and it is the purpose of this inquiry to ascertain in what way and how far they influence the growth of hair and other supplementary organs. The presence of these, whatever be their form or the situation they occupy, is the manifestation of constitutional and local exigencies. They imply the existence of superfluous chemical elements, which have to be emitted agreeably to general and particular vital requirements in the state of hair, horns, or tusks. *The production of them is essential to the preservation of more vital structures.*

An ingenious writer has recently endeavoured to prove, and his views are supported by facts of no ordinary kind, that animal life has been successive in the stages of its development ; in other words, that the beings of the present day are those of a former and extremely remote epoch, modified in organization and functions, in consequence of atmospheric and other changes which have marked the different eras in the existence of our planet.

The animal and the vegetable kingdom, the one investigated in its somewhat fragmentary remains : and the other in its vast extent and altered conditions, give to the views

alluded to a weight and value calculated to arrest attention and interest the philosophical inquirer. The objects which fall under observation could scarcely have been the production of an atmosphere like that which now prevails. Its constitution must have been very different at the periods contemplated. The animal, from its low state of organization,—a fact which will probably not be questioned,—and the vegetable, luxuriant beyond modern experience or ordinary conception, would not only not require the atmosphere we breathe, but the purity of it,—its limited amount of carbon—would have rendered it unequal to the structural demands of either the animal or plant.

This subject is not so foreign to the general scope of these researches as may at first sight appear, and we shall subsequently examine it more at length. The appendages of animals and of vegetables, organs which strikingly characterize them, would in their form, nature, and situation, unequivocally express the influence of external circumstances, in agreement with the agencies by which they were affected. Hence in past epochs of time, great in their remoteness, the animal and vegetable had peculiar external growths which have gradually disappeared from the altered conditions of our planet.

In studying the presence of hair in the human species, we stated that it was not given for purposes of adornment or to heighten the beauty of the human figure ; but on the contrary, was the result of constitutional and local organic necessities. The same remarks apply, with undiminished force, to the various appendages of animals, whether common or singular in their origin and nature.

The more perfect of the lower animals, in comparing them with man, are to be investigated under three points of view.

1st, With respect to their form and attitude as quadrupeds and quadrumana, analysing the important changes to which the various organic structures give rise.

2nd, The differences in internal functions, and in the appropriation of materials employed in the nourishment of the body.

3rd, The degree and nature of the vital actions of the skin.

Man alone of all animals walks nobly erect, and this position is one circumstance accounting for the absence of hair on the general surface of his body. It so influences the circulation of the blood and the action of nervous matter, that they are unequal to the production of those effects which would occasion the growth of it in any degree approximating to that of the lower animals.

Strange as the foregoing remark may appear, and fertile as it is in physiological suggestions, its correctness scarcely admits of dispute. Hair does not show itself in any region independently of the presence of vital power which throws it out as a relief to the operations it creates. The upper and the lower extremities, in man, cannot be moved to any great extent simultaneously. The occasions which call the one inordinately into play are accompanied with the comparative rest of the other. In the laborious occupations of life, according to the nature of them, the movements of the one or the other of the extremities prevail throughout the day. The cutaneous actions resulting from these partial muscular efforts are extremely circumscribed, as compared

with those which would be established by the equal, long-continued, and successive movements of the limbs, as exemplified in quadrupeds. Under these circumstances, *no great amount of blood is transmitted to and maintained on the cutaneous surface,—one of the requirements necessary to the copious development of hair.*

The horse will enable us to illustrate our meaning on this subject, and what is true with respect to this animal will be applicable to quadrupeds generally. His body is covered with hair, variable in the degree of its growth in particular localities, as the neck, the tail, the posterior parts of the limbs, and the fetlocks. If we observe with attention his action, whether walking or at any other pace, we perceive that the entire cutaneous surface is excited, and in such a way that the aroused operations of which it is the seat,—operations not transient, but often continued for a lengthened period, indicate, in this situation, *the presence of a large amount of blood in vigorous circulation*, as well as the distribution of nervous energy in a corresponding ratio. The two conditions are inseparable.

It will not be doubted that the movements of the four extremities, dependent on numerous muscles, the more important of which cannot be exercised without acting powerfully on the surface of the body, will determine to it a quantity of blood far greater than would result from the action of two extremities, in connexion with a different structural conformation.

The question then suggests itself, in what manner can the abundant elements of the circulating fluid contributing to extensive cutaneous functions, be disposed of? In dis-

cussing this matter, in reference to the human species, we find that the transpiration of the skin is principally for the emission of water ; and further, that the escape of this does not lessen to an appreciable degree in particular cutaneous regions, the necessity for the expulsion of various agents existing in the blood, which can issue only in the form of hair. The production of this is the appropriation of them.

In the horse, and in quadrupeds generally, when excited by exercise, the quantity of blood transmitted to the surface of the body is considerable, and at the same time kept in vigorous circulation. Many of the elements which it possesses must have an outlet, which is not furnished by the transpiration of the skin ; and, therefore, we contend that the development of the external appendage is the using up materials which the animal system could not otherwise expel.

The next cause which we have to examine, accounting for the affluence of hair in the class of animals under consideration, is one of great interest from its physiological relations to the principles of this inquiry.

In studying the organic conditions which influence the growth of the external appendage, in man, we endeavoured to prove, that the degree in which it shows itself is immediately connected with the functions of the liver,—the quantity and nature of its secretion. Hence those who are sallow in complexion, and otherwise examples of the bilious temperament, ordinarily display hair in abundance on the face and other parts of the body. The predominance of the bile, it was argued, imparts to the circulating fluid car-

bonaceous and other active elements beyond what occur in other constitutions, and in the ratio of the difference *is the development of the external appendage.*

The labours of Liebig confirm, in an unexpected manner, the justness of this conclusion and the reasoning by which it is supported. It is admitted, and by high authorities, that in the fæces of the human species bile exists, and is probably never absent in health ; so that only a portion of it disappears in the process of digestion, absorbed and conveyed into the circulating current. The analytical labours of this distinguished philosopher clearly establish, that not a trace of it can be detected in the alvine excrementitious matters of the *carnivora*, and only to a slight extent, if at all, in those of the *herbivora*.*

This fact has a peculiar value in reference to the physiological views advanced. The liver in these animals is a large organ, and particularly active in its functions, consequently its secretion is proportionately copious. If the

* "The fæces of carnivorous animals, as of serpents and of dogs, fed with flesh and bones, contain a very small proportion of *organic* secretions, which promote the passage through the intestines of the substances not taken up during the digestive process. They consist chiefly of bone earth, and when incinerated, yield only traces of soluble salts, among which, however, is not found carbonate of soda, which is left when bile is incinerated."—*Animal Chemistry, &c.*, by Baron Liebig. Edited by William Gregory, M.D., F.R.S.E., M.R.I.A. P. 76.

In the work from which the above is taken, the illustrious chemist, in treating of the principles which account for the generation of animal heat, observes : "If, therefore, the circulation and respiration are *simultaneously accelerated*, then according to the beautiful law ascertained by Vierordt, the absorption of oxygen, and with it also the amount of heat set free, will also increase."—P. 228. The researches of Vierordt are recent, as stated by Liebig in the Introduction to his work.

Long before either Liebig or Vierordt had written upon this subject, the law, to which the former alludes, had been explicitly stated by the present writer, in a work published twenty-eight years ago. The language in which it is ex-

whole of this, in the one class of animals, and nearly so in the other, enters into the constitution of the blood, it is obvious that this will be very different in its properties from what it is in the human subject. It will contain a larger proportion of the biliary secretion, a fluid abounding in carbon in various combinations and other active principles, the presence of which in the circulating current, co-existing with certain nervous conditions, is the occasion of the growth of hair.

As we had doubts, whether we were stating accurately or not the views of Liebig on this matter, we have pleasure in quoting the following passage from Dunglison. "Liebig," he says, "affirms, that the constituents of the bile cannot be recognised in the fæces of carnivorous animals; whence he infers that the whole of the bile has been re-absorbed, and he believes, in order that its hydro-carbon may pass off by the lungs. This can scarcely, however, apply to man; and Liebig admits, that in the herbivora a certain portion

pressed, will be admitted to be clear and precise, and cannot possibly be misinterpreted, as the following extract will show. It is simple justice thus plainly to state the fact, and this is the first occasion that has offered itself for our doing so:—

"The explanation I shall give goes far to support the doctrine of Black, in which the increase of heat is attributed to chemical changes in the lungs. It is now, I believe, almost universally allowed, that the arterial is warmer than the venous blood, and it is more than probable that this result depends on chemical action. By taking into consideration *that only a small quantity of the air within the lungs is at any one moment deteriorated; and still further, that the left ventricle contracts seventy or eighty times per minute*, in order to propel the arterial blood which is transmitted by the lungs, we shall have reasons sufficiently ample to account for the possibility of these organs bearing such changes, and for the ease with which the system is supported in an equable temperature. If the body be supposed to possess thirty pounds of blood, and the heart to transmit at each contraction two ounces, and to contract seventy-five times per minute, we shall find that the whole mass will pass through the lungs once every three minutes, or twenty times per hour. As it has been proved by direct experiment that the blood acquires at least one

of the elements of the bile can be discovered in the fæces."*

We must not, however, conceal from the reader the fact, that the question which is here discussed is still agitated among physiologists; nor have the elaborate analyses to which it has given rise by any means afforded uniform results. The progress of animal chemistry can scarcely fail to throw additional light upon it.

If the bile, in the animals alluded to, is not thrown out of the system in connexion with the operations of digestion, or in the same degree as in man, does it not follow that in them the external appendage should be developed in a correspondingly greater ratio? The theory propounded contemplates this result and such is the case.

There is probably no subject that has been more studied, and by chemists of the highest order of intellect, than the constitution of the bile, and none that has elicited the same extraordinary discrepancies of opinion. How little agree-

degree of heat in passing through the lungs, it necessarily follows, at this moderate calculation, *that the system will receive twenty degrees of heat in an hour, or 240 degrees every twelve hours.* If the respiration be accelerated, and the contractions of the heart be increased to 100, the mass of the blood will circulate through the thoracic organs in one-fourth less time than is stated above, and consequently the temperature will be augmented one-fourth: the increase of one degree, instead of being repeated every three minutes, will be repeated every two and a quarter minutes."—*Experimental Inquiry into the Laws which regulate the Phenomena of ORGANIC and ANIMAL Life.* Edinburgh: Macdachlan & Stewart; and Simpkin & Marshall, London, 1829. Introduction, p. xx.

The italics in this extract are as they appeared originally. The leading principles of this work have been adopted by other writers without the slightest acknowledgment. It was done on a large scale by Mr Julius Jeffreys in his "Views upon the Statics of the Human Chest;" and the plagiarism, in all its details, was exposed in the *Lancet* immediately after the publication of his treatise in 1848.

* Opus cit., vol. ii. p. 306.

ment do we observe in the analyses of Gmelin and Tiedemann, Thenard, Berzelius, and other chemical authorities! And we may, at this time, adopt the language of one of these writers : " Il règne encore sur la nature de la bile une incertitude que de nouvelles observations peuvent seules dissiper."

The use of the bile is equally a matter in dispute among physiologists. Some regard it as an excrementitious secretion subservient to no important end in the animal economy : others, with far greater reason, conceive it to concur in an eminent degree in the accomplishment of the digestive process, but in what way is not satisfactorily ascertained. The investigation is one of extreme difficulty. The numerous experiments which have been performed on the lower animals, in the attempt to force nature to speak clearly on this point, have been attended with little success.

That the bile possesses peculiar and exceedingly active principles is unquestionable ; and if the amount in which it is evacuated, in combination with the refuse materials of the alimentary canal, varies in different animals, we should expect to discover the organic effects of it in the character of the constitution, and in the growth of particular external appendages.

There is another circumstance we must notice in connexion with the biliary secretion. The substances which enter into its composition, are not present in the same proportion in animals unlike in organization, nor in those of the same species. Hence a diversity of results, whatever structural form they assume, may be attributable to this cause.

The bile in the human species offers similar discrepancies.

It is indeed neither the same in quantity nor nature, understanding by the latter the proportion of its constituents, in different individuals. A *sameness* in either respect, or within trifling limits, is an impossibility. The blood in circulation, in one case, is more abundant and far richer in vital properties, than in another; and conjoined with these conditions may be the greater activity of the nervous system,—circumstances which will materially affect the biliary secretion, and the degree of its co-operation in the development of supplementary appendages.

The third and last point which we have to investigate, in reference to the quadrupeds under consideration, establishing an important distinction between them and the human species, is *the action of the skin*.

We have treated of the position of the body resting upon and moved by four extremities; and of the bile, which is wholly or in great part retained. The former of these conditions gives to the cutaneous surface an abundance of blood; and the latter requires extensive issues for the escape of its carbonaceous and active principles,—issues which are not, however, furnished by the *transpiration* of the skin. In this description of animals it is characterized by extremely limited functions. A learned writer, in the discussion of this subject, observes:—

“ Chez les animaux à sang chaud (mammifères, oiseaux) la respiration cutanée est à peu près insignifiante. MM. Regnault et Reiset se sont assurés qu'ils pouvaient la négliger dans l'énoncé de leurs résultats sur la respiration. Une poule ne fournit par sa peau et l'excrétion intestinale que la 00.18 partie de la quantité totale, d'acide carbonique qu'elle

exhale quand'elle est tout entière dans l'appareil. Les lapins sont à peu près dans le même cas."*

According to the facts which are here brought forward, it is evident that the vigorous circulation on the surface of the body, and the properties of the blood, will require outlets in this direction, proportionate to the demands of the constitution and of the superficial tissues. The latter are not relieved of their superfluous elements, in the same degree, as in the human species; *yet the local and bodily necessities are greater*. What does nature do under these circumstances? The useless materials of the circulating fluid are not thrown off in the form of sensible or insensible perspiration. This, from its insignificance, is scarcely worthy of valuation.

What nature cannot effect in one mode she does in another. The production of hair over the entire surface of the body, is the appropriation of matters resulting from the processes of life. If they cannot be emitted in one state, they will clearly in another. The affluence of the external appendage, is the expression of constitutional and local organic conditions, and its development is in agreement with the physiological principles laid down.

In treating of the hair, in the human species, we stated that its growth, in particular regions, is in the ratio of the vital actions of which they are the seat, and of the useless elements which the animal system has to expel. We further remarked, that the occasional absence or scantiness of it, in different individuals, is satisfactorily explicable on the views we have studied to unfold. From the consideration

* Bérard, opus cit, vol. iii. p. 557.

of man, we have passed to that of quadrupeds, the cutaneous surface of which is altogether covered with the appendage. The causes pointed out, as peculiar to them, are in our opinion adequate to account for the difference in its production. The profusion in which it exists, is simply in accordance with prevailing constitutional and local requirements; and agreeably to the urgency by which these are characterized, is the amount of the external endowment in quadrupeds themselves. In some it is luxuriant in its manifestations; while in others, and in animals of large size, it is almost altogether wanting.

These peculiarities are to be traced to a modification of the causes which we have endeavoured to define. Food and climate, independently of a difference of organization, will create constitutional and local conditions giving rise to the growth of particular external structures, and unlike in the degree of their development in animals of the *same* species. In fact, while they are present in one, they are frequently entirely absent in others. The accuracy of the statement will be abundantly proved in the course of these researches, showing that the supplementary appendage, whatever may be its character, in beings of the same description, changes with the circumstances by which they are influenced; and, therefore, the presence of it can only be regarded as a measure of the induced necessities of the animal system, and not as an endowment immutable through vast epochs of time, or indeed essential, except in the sense here interpreted, to the existing bodily structures.

We purpose now to make a few remarks on another class of animals, viz.: the quadrumana. Their form and external

appearance possess no ordinary interest in connexion with the matters under discussion. They differ greatly in intelligence, and in the perfection of their organization. While some are capable of walking erect, and with considerable ease; others can move forwards only by means of the four extremities, approximating in their locomotive powers to quadrupeds. In treating of the hairy appendage of the latter, we laboured to show, that the distribution of it over the cutaneous surface, is in part owing to the *prone* position of the body, and the mode in which its movements are effected, by which the circulatory system is proportionately modified in its functions. In the quadrumana we have an opportunity of testing, to some extent, the correctness of this opinion.

In the more highly developed of these animals or which offer the strongest similitude to man, we have the hair very differently distributed, from what it is in those of the same family lower in the scale of organization: and further, what is extremely important to note, *the capability of walking erect is marked by the absence of a tail*. The production of this would appear to be an organic necessity springing out of the position and action of the two hind extremities of the animal.

The apes, which comprise the ourangs, chimpanzees, and the gibbons, make the nearest approach to man, not only in the conformation of the brain, liver, and intestines, but in the general aspect of the body. They are tail-less, and frequently walk erect. Of the first-named, we have ample descriptions in the works of naturalists. Some of these animals are of commanding stature and of great strength. The head and face have a striking resemblance

to those of the human species. The former is round, and has a well-developed forehead. The countenance, save where the beard shows itself, is nearly smooth. Hair is abundant on the upper lip, the angles of the mouth, the sides of the face, and the chin, presenting the appearance of moustachios, beard, and whiskers, as in the vigorous human male.

The hair of the head grows from behind, forwards, and attains five or six inches in length. On the chest, and the fore part of the body, it is thin, as compared with its luxuriance on the back and flanks. In the one which was minutely examined by Tyson, the hair on the anterior regions was so scanty that the skin was everywhere discerned, and in some places it was almost entirely wanting; so that, when the animal was erect, a position it often assumed, the resemblance to man was indeed remarkable. We may further state, that the hair on the pubis was likewise copious.

All authorities concur in the general correctness of this description. It is, however, worthy of observation, that individuals of the same species, will differ in the degree in which the hairy appendage is developed from a variety of causes, some of which are easy of appreciation—as food, keeping in view its quality and the ease with which it is procured; external influences in a comprehensive sense; and the more or less robustness of the animal system;—circumstances which modify the growth of hair in man.

These facts have a direct application to the researches in which we are engaged. In investigating the causes of the growth of hair on the human countenance, we endeavoured to prove, that the regions in which it ordinarily profusely

appears, *have peculiar organic conditions*; as a concentration of nervous power, an abundance of blood-vessels, and activity of circulation; and, lastly, that the parts are frequently excited by muscular movements. These influences, in the aggregate, in relation to the necessities of the animal economy, are the occasion of the emission of chemical elements in the form of supplementary structures.

In the orang-outang, we have organic and functional conditions of the head and countenance differing little from those of man, and in perfect accordance with the physiological principles advocated, the hair is developed luxuriantly in the same regions—as the head, the upper lip, the chin, and the sides of the face—and why? The answer is obvious. The animal possesses a like distribution of nerves and blood-vessels, in connexion with analogous bony and muscular structures, and hence the manifestation of corresponding effects. The trifling discrepancies which may exist do not affect the broad outline of comparison instituted.

This animal, however, offers other and more interesting phenomena bearing on the present inquiry. Its organic endowments are the connecting link between man and quadrupeds. It partakes largely of the qualities of both. It has not the steady and easy erect position of the one; nor has it the necessary prone movements of the other. It has the power of walking erect, though very imperfectly as compared with the human species; nevertheless, the degree in which this is accomplished, and its other varied attitudes, *remove it widely in bodily conformation and actions from quadrupeds.*

In harmony with its structural conditions is the modifi-

cation in the distribution of nervous power and of blood; and in the growth of the external appendage, as compared with man, on the one hand, and quadrupeds on the other. The neck, chest, and fore part of the body are nearly bare, or are extremely scantily clothed with hair. On the physiological principles advanced, these effects would be anticipated from a knowledge of the frequent position and movements of the animal frame.

We have endeavoured to prove that the circulation of the blood, and the diffusion of nervous energy, will vary with these circumstances; and to the same extent the local and constitutional requirements for the emission of superfluous matters from the superficial regions. The erect position of man, as we have remarked, is one cause of the smoothness of the cutaneous surface, conjoined with the relatively less amount of bile retained in the body, as compared with the higher classes of quadrupeds; and there is likewise a difference in the *quality* of the biliary secretion, which may greatly affect the development of the supplementary structures.

Human bile is much less bitter than that of the herbivora; and as that of the fœtus has very little bitterness, we may reasonably conclude, that the degree in which this quality exists, is a measure of those properties which constitute the activity of the fluid, displayed in the vital actions which it excites, and the necessities it creates for the expulsion of useless elements from the surface of the body.

How far the bile is retained or evacuated with the fæces, in the quadrumana, we unfortunately possess no information. We are not aware of any investigations to determine the

point, which certainly is fraught with considerable physiological interest.

The next species of ape to which we shall allude, is the *Troglodytes niger*, or chimpanzee, an animal stated to be less in stature, but having a closer resemblance to man, than the orang-outang. The opinions of writers are not uniform concerning its size. By some it is said to be equal or superior in this respect to man; by others, and apparently with greater truth, it is described as seldom exceeding three feet in height. "Its hair is dark brown, or blackish; its head is conic, the body brawny, the back and shoulders are hairy, and *the rest of the body smooth*." Two that were brought from the forests of the Carnatic "were scarcely two feet high, but walked erect, and very nearly resembled the human form."

From the extraordinary resemblance of this animal to the human species, it was designated by Linnæus, *homo Troglodytes*: and the same considerations have led M. Bory de Saint Vincent, to place it at the side of man, in the order *bimana*. The latter writer, in his description of it, shows the striking structural affinities between the two. It has, he remarks, the smooth and elevated brow, and not only walks erect, but is embarrassed or inconvenienced when forced to assume any other position. The skeleton differs only slightly from that of man; and the animal has likewise the *os hyoides*, a bone which serves to support the tongue, giving attachment to a variety of muscles concerned in the movements of this organ, and in the actions of the larynx and fauces. The jaws have the same number of molar teeth, and the same in form as those of the human species;

and the countenance, like that of the latter, is capable of expressing strong and refined emotions. He alludes to the hand, as an exquisite organ of touch; and, lastly, to the large development of the gastrocnemii and other muscles enabling the body to stand and move erect.

The last animal of this class which we shall notice, is the gibbon or the long-armed ape, of which there are several species differing considerably in size, and in the colour and distribution of the hair. They are equally tail-less and capable of walking erect. Some of them have a circle of bushy white hair all round the visage, while in others it is grey. In the siamang, another species, the circle is wanting, and the face is smooth, as are also the breasts of the female.

On quitting the apes, properly so called, descending in the scale of organization and intelligence, we meet with a great variety of animals, diversified in form, size, and external appearance, and to which the term monkey is usually applied. It is not our business nor intention to enter into a description of them. We shall simply advert to certain striking differences which they offer, as compared with the apes. In the baboons, some of which are large and powerful animals, the face is long, the muzzle broad and high, the teeth canine, the buttocks distinguished by naked callosities, and, lastly, a tail is present, variable in length. In the magots, in place of a tail, a tubercle only exists. The baboons walk much more commonly upon all fours than upright. *They are covered with long thick hair, and somewhat uniformly, though more sparingly on the under surface of the body.*

The points which alone concern this inquiry are the struc-

tural conditions of the face, implying by these the bones, muscles, nerves, and blood-vessels, of which it is composed; the quadruped-like movements of the body, the abundance, and the general distribution of hair over the cutaneous surface. A change in the conformation of the face is accompanied with a corresponding modification in the development, and in the course or direction of its nerves and blood-vessels, and in the muscular motions to which these are subject.

These organic endowments establish particular functional necessities; or, in other words, a difference in the degree in which chemical elements are emitted, and, in the instances under consideration, in the condition of hair. Hence the diversity of appearances which this presents in animals of the monkey tribe. Some have it in the form of manes, others have it on the top of the head disposed as radii; a third have tufts at the side of the face; and a fourth have a bushy appendage all round the visage. These peculiarities are the manifestation of organic states, the same in kind as those which give rise to the beard and whiskers, in man, and the apes, and the growth of them is in accordance with the physiological principles brought forward.

A predominance of quadruped-like movements, creates circulatory and nervous conditions very different from those which prevail even in the ape, and as a consequence the cutaneous surface has far greater exigencies for the expulsion of those useless matters which can escape only as hairy appendages. Hence, as the animal departs from the type of man, and assumes the physical and mental qualities of the quadruped, the body is more profusely covered with hair.

It is not necessary to extend this branch of the investiga-

tion. The facts advanced are sufficient for the purposes in view. We may, however, state, that as we descend from the apes, to animals of the same family lower in the scale of organization, the liver, the stomach, and intestines, differ greatly in structural conformation; and consequently in the functions they exercise, as compared with the same organs in animals more closely allied to the human species. These may be circumstances which modify in an important degree the properties of the blood, giving rise, in fact, to constitutional requirements for the emission of elements from the surface of the body, which may not exist, to an equal extent, in animals only a few degrees higher in the scheme of creation.

CHAPTER IX.

CAUSES OF THE DEVELOPMENT OF PARTICULAR HAIRY APPENDAGES IN THE HIGHER CLASSES OF QUADRUPEDS.

WE have endeavoured to trace the causes giving rise to the growth of hair over the entire surface of the animal body. The organization and functions of the quadruped are shown to be very different from those of the quadrumana, and proportionately the accompanying supplementary appendage. The development of it, in each, is in accordance with the particular structures and vital actions of the individuals, and in agreement with the physiological views advanced.

The general facts which we have studied to establish, furnish a natural transition to the consideration of others inseparately connected with them; as the presence of hair in extraordinary copiousness in certain cutaneous regions, as the neck and legs of the horse, and the neck and head of the most powerful of the carnivora. The principles of which we have treated, will be found to afford a satisfactory explanation of this interesting class of phenomena.

We shall examine the growth of hair in the several

regions of the horse. The supplementary structures by which he is distinguished, are familiar to every one. We may observe, previously to entering upon the task, that the facts and reasoning adduced on this occasion, will apply with equal force to analogous productions in other animals. The examples we shall bring under consideration will necessarily be few, but sufficient to illustrate and confirm the accuracy of the views brought forward.

The hair on the face and lateral parts of the neck, in the horse, does not grow to the same extent as on the general surface of the body. The movements of the animal do not affect the former in the same degree as the latter; and according to the vigour of the vital actions, in the several cutaneous regions, supposing other things to be equal, is the amount of the external appendage. We have here the manifestation of cause and effect, the latter varying in strict correspondence with the modifications of the former.

One of the most striking and ornamental features of the horse, is the mane, which is common to both sexes. It is, however, much more exuberant in the male than female, showing that, in the former, the functions of life are characterized by greater energy, from the influence of the generative system. Hence agreeably to the difference, is the amount of elements to be emitted from particular localities of the body in the condition of hair.

The mane extends from the upper part of the head to the beginning of the shoulders, and in the entire horse grows to a great length. Why it should be confined to this limited space we shall endeavour to explain. The circumscribed development of it agrees with the anatomy of the parts and

the distribution of nervous power. The dorsal and lumbar portions of the spinal marrow find an issue for their nerves, and the expenditure of their power, in three directions.

1st. They communicate with the sympathetic in the abdomen, imparting nervous energy to the whole of the viscera. 2nd. They send off large nerves to the strong muscles of the back and loins, and to the cutaneous surface. 3rdly. The hind extremities derive the whole of their nerves from them. The greater part of the first dorsal nerve goes to the formation of the cervical plexus, from which nervous agency is transmitted to the fore extremities.

The dorsal and lumbar divisions of the spinal cord have an outlet for the nervous principle in these directions. In treating of the spinal column, in the human species, the external surface of which is extremely smooth, it was stated that it would have possessed hair in abundance, had the actions of the enclosed cord had a reference only to its own structure; or, in fact, had it not been in such intimate relation with remote parts of the animal system, the movements or operations of which *draw off the nervous energy as it is created*. It has an issue in responding to these demands.

The cervical portion of the cord, in the horse, which gives origin to the mane, displays very different conditions from the dorsal and lumbar regions of it. The parts to which its nerves are distributed, are in a great measure structures in its own vicinity; and their requirements are less from the nature of the functions which they perform, than those in connexion with the abdominal viscera, the muscles of the back and loins, and the four extremities.

We shall proceed to establish the justness of this opinion.

The first five cervical nerves are almost exclusively expended on the muscles in the immediate neighbourhood, as the *complexus*, the *longus colli*, the *panniculus*, the *spinalis colli*, the *splenius*, and the *levator humeri*: nervous cords are likewise sent to the jaw, to the root of the ear and its muscles, as well as to the superior, inferior, and the lateral regions of the neck. The sixth and seventh cervical nerves, after transmitting branches to several muscles, enter into the formation of the humeral plexus.

In corroboration of these views it may be observed, that the cervical vertebræ are *larger* than either the dorsal or lumbar, and equally so the channel which receives the spinal cord; from which we may infer, that the latter, in this situation, is developed to a greater extent than either of the other two divisions of it.

From these, and other differences that might be named, the cervical portion of the cord clearly possesses peculiar structural and functional endowments. The actions to which it contributes, are chiefly in its own vicinity, and expend a *less* proportion of nervous power, than those excited through the dorsal and lumbar regions of the same nervous substance.

From these causes, it will be a *centre* of greater nervous operations than the other parts of the spinal marrow; not having, like the latter, the same extensive outlets for its nervous energy, others will be created in accordance with its requirements, and in illustration of the fact we have the flowing mane.

The cervical portion of the cord approximates somewhat to the physiological conditions of the human brain, the useless elements of which are appropriated in the production of a copious external appendage.

On these anatomical considerations we should calculate on the presence of hair in the cervical region, in the ratio of the concentrated actions of which it is the seat. The mane is the result and measure of them, not only in the horse, but in every animal that possesses the endowment. The hairs of which it is formed are much stronger than on the cutaneous surface generally,—a fact which it is important to keep in mind ; as showing that the circumstances in which it originates are very different from those belonging to other parts of the body.

The mane, as we have remarked, is more exuberant in the male than female, and from the influence of the generative organs ; so that there are local and constitutional causes co-operating in its formation peculiar to the more vigorous sex.

We have laboured to prove, that the cervical portion of the cord, is not subject to the same extensive demands on its nervous energy, as the dorsal and lumbar divisions of it : and, therefore, according to the degree of its concentration, or the more limited application of it to the general purposes of the animal economy, is the growth of the mane. Its greater development in the entire horse than the mare, and the absence of it in the lioness, clearly demonstrate, that the discrepancy is the expression of the difference in the amount of surplus matters which the body has to emit.

A recent writer, in attempting to account for the supe-

riority of this appendage in the male, observes, that "it forms a shield to the neck in combat, and for this reason it is more luxuriant in the male than female." * This line of argument is adopted with respect to various supplementary structures of the lower animals. When the physiologist fails to discover the vital conditions by which they are thrown out, though by no means uniformly present in connexion with the same exact scheme of organization, he at once concludes, that the end to which they are subservient, is to enable the animal to *fight* with greater advantage. Such reasoning is peurile and unworthy of serious notice. It throws no light on the nature of the causes occasioning the growth of this class of organs.

There are other matters which merit attention in reference to the horse. He has hair, and often in great copiousness, on the fetlock and its contiguous parts.

The consideration of it, in these situations, opens out a field of inquiry abounding in interesting physiological phenomena, and in direct relation to the views brought forward. We are fully sensible, that objections may be urged to the principles pervading these researches; on the ground, that the several appendages which we have studied to explain,—pointing out the local and constitutional causes by which they are produced,—the end they serve, as outlets for the escape of chemical elements,—are endowments inherent in the plan of creation; and, therefore, it may be contended, that it is unphilosophical, and in vain to attempt to account for their existence. Every thing that occurs is in the plan of an all-ruling Power, being the result of laws im-

* The Anatomy of the Horse. By William Percivall, M.R.C.S. P. 410.

pressed on matter. But how greatly are the productions of nature, animate and inanimate, modified in structure, and in the manifestation of a variety of external conditions, by culture and the influence of external circumstances, not in opposition to, but in exquisite agreement with these laws!

The hair on the fetlock, like the mane springing from the neck, may possibly be regarded as a necessary appendage of the horse. Arguing on this view we might ask: if necessary, and, consequently, instrumental to some valuable purpose, how does it happen that man has the power of preventing its growth? It substantially disappears, when care and judgment are bestowed in the breeding of the animal. The race-horse, and the thorough-bred hunter, display it in its lowest degree. In them it is absent, as compared with its imposing form in the heavy dray or common draft horse, in which, from its profusion, it nearly covers the foot.

The writer, whose opinion we have just quoted, in reference to the use of the mane, observes—"that the tufts of hair sprouting from the fetlocks defend those parts from contusion when forcibly depressed in action, and serve, at the same time, as a protection to the heels." It is not very clear in what way they are capable of accomplishing these results. Were they designed for either of these ends, man would have little power in arresting their growth. What is essential to the well-being of an animal, in the sense in which the writer shows the utility of the tufts, would not, we conceive, be susceptible of any remarkable change from human interference. The race-horse has only the merest traces of them; yet, according to the argument employed, he should possess them in abundance, from the extremely

severe pressure and violent action to which the joints of the four extremities are subjected.

The hair on the fetlock is found in greatest affluence in the heavy dray-horse. The form of the animal is well known. His large proportions in all directions are familiar to ordinary observation. The body is considerable in bulk, and the limbs are correspondingly developed. His step is slow, but indicates power. His strength is great.

Of late years the study has been, in the breeding of this description of animals, to modify the combination of his qualities. To obtain greater compactness of bone and muscle, and to impart to them greater facility of action. In other terms, the object has been *to change the character of the nervous system*.

We shall analyse the animal in his well-known and yet prevailing properties. Were we to define his temperament, which has its useful applications, we should designate it as the *musculo-lymphatic*. The hair covering the body is long and coarse. He is a gross feeder, readily makes flesh, and especially fat. In spirit he is dull rather than lively: in temper docile and rarely vicious.

The conditions which particularly force themselves on our attention, are the activity of his digestive organs, and from the quantity of food he consumes, the consequent abundance of blood. This, however, is deficient in stimulating qualities. We arrive at a knowledge of this fact chiefly from two considerations: the limited energy displayed by the nervous system; and the tendency to the formation of fat, creating a plethora of the body, which shows itself in the diseases to which the animal is liable. His temperament and habits

confer upon the blood the properties which are here stated to distinguish it. The accuracy of this opinion is scarcely questionable. The circulating fluid, from its constitution, abounds in elements which require external outlets. They have to be thrown off in the degree of their production; and among the means which nature provides, is the luxuriant development of hair on the cutaneous surface generally, but particularly in certain regions, as the fetlock, and the parts immediately above the hoof.

It may probably be asked: why does the hair show itself in extraordinary copiousness in these situations? There are three causes we shall point out as explanatory of the phenomenon.

1st. The growth of it is upon, and in the vicinity of, a large joint, and the *last* of the limb.

2ndly. The structures where it appears are extremely vascular. The blood-vessels assume in them a remarkable arrangement previous to their termination in the foot, the physiological conditions of which we shall subsequently touch upon.

3rdly. In connexion with the peculiarities mentioned, is the important fact, that the weight of the body is thrown upon the pastern joint and its contiguous structures, exciting the nervous and vascular actions natural to them; and proportionately aggravating the necessity for issues to facilitate the escape of superfluous chemical elements.

In studying the second head, it is evident that the arteries and veins, *in the higher parts of the limb*, have a ready passage for their contents in two opposite directions. They are not aggregated into a thickly reticulated form preparatory to

a change of distribution; consequently the motion of the blood in them is not liable to serious embarrassments. The vessels, in the pastern joint and its associated tissues, are very differently circumstanced. In these they divide and subdivide, giving to the structures a high degree of vascularity, which is the occasion of correspondingly excited actions : hence the presence of hair in considerable quantity.

The three causes here specified are the occasion of the frequent disease of these parts, producing what is called *grease, cracks, ulceration, and fungous excrescences*.

The copiousness of the external appendage on the fetlocks, is a measure of the necessities of the structures by which it is thrown out. The fact does not admit of doubt, and the principles on which it is explicable, offer many points of deep interest. The blood, as we have stated, is rich in carbonaceous and other materials, which are emitted in the form of hair in certain cutaneous regions, in the degree of the vital operations by which they are characterized.

In the race-horse, the appendage may be regarded as absent. We observe merely the slightest appearance of it. The legs are beautifully free from superfluous hair. The animal is an admirable example of the *nervo-muscular* temperament. The care bestowed in the breeding of him, gives to the limbs their just proportion and position; secures bone and tendon compact and strong; distributes the muscles where they are wanted for strength and agility; develops prominently the nervous system; and, lastly, imparts the capacious chest. Hence his power, speed, and enduring qualities. The spirit and energy of the animal are portrayed in every feature and action of the body. Motion

seems his necessary state of existence. How restless and teeming with expression is the eye! How tremulously agitated are the fine muscles of the countenance! Life moves along them in quivering and fitful undulations.

These phenomena are evidence of the predominance of the nervous system, and of the exuberant animating principle by which it is pervaded. We have here no waste flesh;—no fat concealing the form and impeding the movement of muscles. Bone, muscle, and nerve are in their right places, and exquisitely adjusted for the attainment of the objects contemplated.

We have next to advert to the capacious chest, and the comparatively small abdomen. The organs of the former have ample space for the vigorous performance of their functions, the effects of which are the thoroughly oxygenated condition of the blood, and the admirable breathing qualities of the animal.

The activity of the nervous system, and the state of the circulating fluid, are inimical to the production of fat. This, with the degree of exercise essential to health, is in its lowest state of development.

It is not difficult clearly to explain why the race-horse has a much finer coat than the heavy dray-horse, and is almost entirely free from superfluous hairs on the lower half of the posterior regions of the four extremities, including the fetlocks. The discrepancies between the two animals are great. While they have much in common, they are separated by remarkable structural and functional differences; and to trace these, in the modification of an external appendage, is an important physiological inquiry.

In the race-horse there is no plethoric state of the constitution;—no natural grossness unequivocally implying a superabundance of blood ; or, if this fact be questioned, the circulating fluid is not charged with elements requiring outlets, beyond what exist in the production of the characteristic appendages of the animal. The blood is rich in *oxygenated* properties, and of course correspondingly deficient in carbon. An excess of the latter, according to the nature of the prevailing vital actions, is *appropriated either to the formation of fat or of hair*. The former of these substances can scarcely be said to be present, and the latter is nearly absent on the fetlock. The mane is likewise thin, and the tail has only a few long hairs. From these facts it is clear, that the constitutional necessities of the animal for the production of supplementary structures, are considerably less than in the common dray-horse.

In a previous portion of these researches we have remarked, that two classes of causes are essential to the abundant growth of hair, viz. : certain local organic conditions, *and a particular state of the blood*. If this does not possess the properties defined,—a copiousness of carbonaceous and other materials,—the former will be inadequate to the development of the several appendages, which indicate the existence of the materials in question, and the degree in which they are thrown out in structural forms is a measure of them.

It is obvious, from the organization of the race-horse, that the blood in circulation is very different in its qualities from that in the duller-bred animal. The relatively larger capacity of the chest, as compared with the abdominal

cavity, leaving out of consideration, which would lend additional weight to the argument, the nutritious and stimulating nature of the food on which he is fed, creates blood which is very highly oxygenated. To deny the justness of this conclusion, would be to question the most evident of physiological principles: and we further contend, that the other inference which is drawn, viz., the presence of hair according to the local and constitutional conditions pointed out, is equally indisputable.

In the attempt to elucidate this branch of the subject, we have selected two animals of the same species, but very different in form, capabilities, mental character, and in the manifestation of the hairy appendage. We have analysed the causes which modify the growth of the last named, and in such a way as to render them intelligible to the ordinary understanding. It will probably be admitted by the candid and philosophical inquirer, that the effects are in perfect accordance with the organic conditions of which we have elaborately treated throughout these pages.

We might further strengthen these views, and the distinctions established, by alluding to the morbid affections to which the two animals are liable. They are very different in their nature. In the race-horse, they generally display *acute* inflammatory symptoms, soon run their course, and end fatally, if not checked by prompt and active means. They are an unmistakable indication of the vital conditions which exist. The animal is little subject to *grease* and analogous disorganizations, which are of frequent occurrence in the heavy draft-horse, great in bulk and slow in his movements.

From the foregoing observations it will be acknowledged, that the hair on the fetlock is suggestive of deeply interesting investigations. The degree in which it appears, reflects with considerable accuracy the attributes of the horse. To the physiologist, it is what the single bone was to the clear and capacious mind of Cuvier. In each case, we may ascend from an apparently insignificant object, to a just conception of the form, qualities, and functions of the animal.

In the lion, we have a further illustration of the same views. In its wild and savage grandeur it is the noblest of the brute creation. Between it and the horse, we discover remarkable differences in the direction and activity of the vital powers. The one displays, in appalling magnificence, the force and energy of uncurbed nature. The head and face express these qualities, and equally the large nervous connexions between them and the *cervical* portion of the cord. Action and re-action between these structures are on no ordinary scale. Mark the animal in its aroused excitement when tearing the dead or living flesh! We have an unequalled exhibition of muscular and nervous properties. The organs in which the nervous system is awakened, in its highest intensity, are those of mastication, the brain, and the cervical region of the spinal cord in particular. If in any animal the two latter necessitate the presence of an external appendage in extraordinary affluence, it is in the lion. What do we observe in his conformation? The mane in its singularly grand profusion enveloping the head, face, and neck. The copiousness of it is in harmony with the local and constitutional conditions existing.

The lion is interesting to study, from the differences by

which it is distinguished in the several regions of the globe where it is found, displaying in a striking form the influence of climate and other causes. The discrepancies are remarkable, in regard to the amplitude, as well as the colour of the mane, establishing beyond dispute the fact, that it is thrown out in degree according to prevailing constitutional requirements, by which is to be understood the greater or less abundance of carbonaceous and other materials, which have to be expelled from the surface of the body. A difference of climate and of food, the latter varying in quantity and quality, will produce important modifications in the external endowment; and, therefore, this is to be considered a natural characteristic of the animal, only so far as its growth is the expression of local and constitutional exigencies. The increase or diminution of these is necessarily accompanied by a proportionate change in the development of the mane.

The appendages of the lion are not the invariable accompaniments of the animal. They are a species of efflorescence, and are present or absent, ample or sparingly developed, according to the character of the powers of life, or the more or less vigorous conditions of the body.

It is in Africa that the lion is found in all its grandeur, being exceedingly powerful, bold, and fearless in disposition; and the hair on the body is proportionately luxuriant. The mane is of immense size, and, in the finest examples of the species, is nearly black, giving to the animal an expression of terrible ferocity. The hair is long and copious on the head, temples, chests, the under jaw, breast, the hinder part of the legs, and often extends as a medium line along the belly.

The Asiatic lion is much less abundantly endowed with hair in the several cutaneous regions specified. The mane is much more scanty, and is of a light yellow colour. The head is described as wanting the width and nobleness of countenance so remarkable in the African species. The lion of Guizerat is destitute or nearly so of a mane, and of long hair on other parts of the body. In disposition it is less fierce, bold, and formidable, and somewhat less in size, than the animal possessing the imposing and flowing external appendages.

The differences in the growth of hair in the same species of animal, do not in any degree affect the justness of the principles advanced. On the contrary, we regard them as furnishing corroborative evidence of their truthfulness. Organic structures and functions are modified according to the influence exercised by external circumstances. Constitutional necessities, indicated by the production of hair, differ greatly in individuals of the same species. One may be invigorated by the causes to which it is subjected : another may be regarded as enfeebled from having its organization imperfectly excited ;—in fact, peculiarities of this kind are inevitable, and equally so the structural changes which fall under observation.

From these considerations, it is clear that the mane has not been given as an ornament ; nor for any utility or end it serves as an external organ. The endowment is not universal. It varies in the degree of its development according to the vigour of the animal system ; and in some males, of the same species, is substantially wanting. The explanation we gave of the appearance of hair on the fetlock of

the horse, applies with equal force to the mane of the lion.

These appendages are, therefore, not to be considered as performing an office essential or beneficial to the animal, in the sense in which this utility is generally interpreted. The presence of them expresses constitutional exigencies, as the foliage and flowers of a tree indicate an abundance of nutritious elements, which have to be thrown out from within, outwards, agreeably to the principles of vegetable life, as manifested by the individual plant. The same views and reasoning have an application to the latter, as well as to the animal kingdom.

Long epochs of time, conjoined with particular influences, are capable of producing effects, in the form, and attributes of animals and plants, beyond what would be conceived possible, from the phenomena which fall within the sphere of ordinary observation, or the narrow boundaries of individual experience.

In treating of the human species, we dwelt at considerable length on the differences of the male and female, with respect to the growth of hair. We traced the causes, and we trust satisfactorily, which account for the smoothness of the one as compared with the other. We observe similar discrepancies between the lion and lioness. The one has the majestic mane,—the other is destitute of it. The generative system is the source of these differences. In the one, it sends the current of life from within, outwards; and in the other, this is drawn from without, inwards.

It is, therefore, clear that endowments of the kind we are here contemplating, owe their existence to conditions

of the constitution by no means difficult accurately to define.

It is not our intention to extend this branch of the inquiry, investigating the peculiarities in the growth of hair in other quadrupeds. We are more anxious to establish principles, and show their application in a few familiar instances, than to multiply examples; which, so far from throwing additional light upon the subject, would rather tend to distract the attention, and weaken the impression which the evidence brought forward may be calculated to produce.

In analysing the causes of the growth of hair, in man, we pointed out *certain structural conditions*, which, in conjunction with constitutional circumstances, cause the development of it in certain regions of the face, as at the sides of it, where the whiskers appear, on the upper and under lip, the chin, and beneath the lower jaw.

We observe similar manifestations in the lion, and from the influence of the same local states. The cheeks and the under jaw are abundantly provided with hair; and the profusion of it is in the ratio of the nerves and blood-vessels distributed to the parts, and the muscular movements to which these are subject.

CHAPTER X.

CAUSES OF THE DEVELOPMENT OF HORNS IN RUMINATING
ANIMALS.

WE enter upon the consideration of a description of quadrupeds, very different in organization, and in the supplementary organs by which they are characterized, from the animals previously brought under notice. The Ruminantia, with few exceptions, possess horns.

The principles we have studied to develope, establish, at least, a claim for their candid examination, on the ground of the interest with which they invest, and the light they throw on the causes occasioning the growth of particular structures. We proceed now to investigate the origin of other external endowments, distinctive of an extensive class of animals. Before proceeding, however, to the discussion of them, and of the local and constitutional circumstances on which their production depends, we shall offer a few general remarks.

In the researches in which we have thus far been engaged, two facts have been proved,—facts which no ingenuity, in our opinion, can invalidate,—viz.: that the growth

of hair in profusion, in any cutaneous region, is, on the one hand, the expression of certain vital states of the animal system, creating an abundance of superfluous chemical elements; and on the other, *of the existence of peculiar local structural conditions*, which, from the influence they exercise, are outlets for the escape of the matters in question in the form of hair. If these are insufficient in amount to require an external issue of the kind or from the action of internal organs, are disposed of in other modes, the appendage will either be altogether absent or imperfectly thrown out.

It is not easy to imagine what objections can be raised to the justness of these conclusions. They rest on numerous and indisputable facts, as clear and unequivocal in their signification, as any within the range of physiological science. The character of the appendage does not at all affect the truthfulness of the principles. Whether present, as hair, horns, or tusks, it is equally explicable on the same views. The nature and situation of it will vary with the organization and habits of the animal. But in whatever locality of the body it appears, it will be found to spring from structures which are the seat of excited vital actions; and invariably in connexion with a concentration of nervous matter. It is this, and the energy of the operations by which it is distinguished, that determine the growth of every supplementary organ, and the region it occupies: hence the beard, whiskers, and hair on the face, head, and pubis of man; the mane and tufts on the neck and fetlock of the horse; and the extraordinary copiousness of hair in the lion. In all these cases, the degree in which it is deve-

loped, indicates with unerring accuracy the constitutional and local necessities which exist.

Ruminating animals are low in the scale of intelligence, and their small mental capacity is accompanied by a remarkably retreating forehead. The prominence of the cranium, is at its upper and posterior parts where the horns grow. The brain is generally of an oval form, and is larger behind than before. The Medulla Oblongata,* from which the cerebral nerves arise, in relation to the size of the brain, is considerably greater in these animals, than in man. The difference, in this respect, it is important to note, as it shows a higher degree of nervous power; and the region is the seat of proportionately more extensive actions than occur in the human species.

The term *ruminantia*, is derived from the singular faculty possessed by these animals of masticating their food a second time. They have four stomachs. The herbage, coarsely bruised, passes from the first to the second, and from this it returns to the mouth to be re-chewed; and, after this process, is conveyed into the third stomach, and thence into the fourth, which is the true organ of digestion. The animal generally remains at rest during this operation, which lasts until all the food received by the first stomach has undergone these several changes.

The functions of one portion of the brain are exceedingly active; viz.: those which minister to smell and taste. In no other class of animals, is the latter gratified to the same extent, understanding by this, not the intensity of the feelings which it awakens, but the protracted duration of them.

* This was regarded by Gall as the central point of all the nerves of the human body.

It is important here to observe, that every vital action, except perhaps purely mental operations, is accompanied with excitement in two kinds of structures, possessing little or nothing in common: in those which are directly instrumental in the production of specific effects, as the mastication of food,—the conversion of this in the stomach into a pulpy substance, and the subsequent elaboration of it in the intestines; and, as additional illustrations of our meaning, the secretion of urine and semen, and the phenomena characterizing the emission of them. The other structures essentially necessary to these results, but remote from the organs in which they take place, *are the nervous centres, as the brain and spinal cord.* The former, are means for the performance of particular ends. The latter, are sources of nervous energy, varying in the direction it takes, and the quantity in which it flows, according to the exigencies which exist.

The aroused operations, in the one class of structures, imply a corresponding excitement in the other. They act and re-act on each other, and important changes in the conditions of both are the consequence.

The principle here stated is exceedingly fruitful in its application; probably indeed to a greater extent than any other professing to elucidate the phenomena of life.

The sense of smell, in the animals under consideration, is stimulated by the presence of food, either in the mouth or uncropped; and hence the copious transmission of nervous power to the capacious apparatus of olfaction. The organs of taste are equally affected: the mouth, glands, and associated muscles, are the seat of its external effects. The

nervous energy determined to them, is the occasion of an abundant secretion of saliva. The degree in which it is produced, *is a measure of the activity of that portion of the brain directly concerned in the process of mastication.*

Animals which do not ruminate, satiate their appetite, when food is at hand, in a short time. Mastication in them is active, but for a brief period only. On its cessation they rest, and the nervous system is then engaged in responding to the demands of the successive stages of digestion : it is active in relation to the organs in which these are carried on.

In the ruminant it is otherwise : the cropping and swallowing of the herbage are only initiatory steps towards satisfying the requirements of the animal. It is in fact the beginning of a long masticatory process, occupying a very large portion of the twenty-four hours ; and the continuance of it is marked by the action and re-action between the muscles, glands, and nerves of the mouth, and jaws ; *and that region of the brain in particular through which nervous power is supplied to these structures.* That part of the cerebral tissue exercising this influence, is, therefore, a persistent centre of nervous operations ; and, according to the principles of this inquiry, we should calculate on the production of external appendages, in harmony with the induced necessities of this tissue, and of the constitution at large ; the character of it will depend on the condition of the vital powers generally. If surplus elements have to be thrown out, in any form, the cerebral centre in question will be one of the issues which nature provides ; and hence the evolution of horns, very unlike in size in animals of the same

species, and displaying great discrepancies in the several divisions of the ruminantia.

The remarkable differences with respect to the supplementary organs, in individuals of the same species, unequivocally prove, that there is a local and constitutional cause directly interested in the growth of them ; and that the degree in which they are developed, is simply evidence of the prevailing and imperative exigencies of the animal system, by which is to be understood, the amount of useless matters necessary to be emitted. **THE CEREBRAL ACTION DETERMINES THE LOCALITY FOR THE ESCAPE OF THEM ;** as the glands, nerves, blood-vessels, and muscles, at the lateral regions of the face, in man, are the occasion of the growth of whiskers.

Wherever a predominant action is established, there external effects are observed in accordance with it. Whether hair in extraordinary copiousness, or horns, the origin of both is dependent on similar local and general causes. The vital centre which is created, in the cerebral tissue of the ruminantia, becomes a channel through which superfluous matters find an outlet.

We are fully sensible that the doctrine here advanced, will be somewhat startling to the mind on its first announcement. The endeavour to explain the causes of the growth of horns, will be looked upon as bold and presumptuous ; a large portion of mankind regarding such matters as beyond the scrutiny of the human understanding, and indeed scarcely falling within the sphere of legitimate inquiry. It would be absurd and prejudicial to the progress of truth, and the diffusion of knowledge, to attempt to chalk out a line beyond which

philosophical research shall not extend ;—a line circumscribing the inquisitive and restless excursions of thought. Man may err in his speculations, but it must not be forgotten that grave errors frequently lie near important truths ; and that the discovery of the latter, is often due to the stirring influence of the former,—the ground they break up, and the interest they impart to objects previously unnoticed. If our own labours are of this kind, they may have the ambiguous merit expressed by the poet :

“ Si non errasset, fecerat ille minus.”

Horns are not the invariable accompaniments of the same species of animal ; nor when present are they alike in form or degree of development ; consequently there is a large field for investigation. The differences they present originate in constitutional peculiarities, which it is the business of the physiologist to analyse.

The mastication of the food, occupying a considerable portion of the twenty-four hours, will keep in excited activity numerous nerves distributed to muscles, glands, and other tissues instrumental to the process ; and the nerves so employed, derive the power on which their efficiency depends, from that region of the brain whence they arise or with which they are intimately connected. *We have, therefore, a cerebral centre of aroused vital operations, in exquisite agreement with those in which the nerves are engaged ;* and these operations, according to a law of the animal economy, create elements, which have to be expelled in the ratio of their production, and the issue occurs in the formation of horns. In the further prosecution of this inquiry, we shall adduce additional evidence in confirmation of the justness of

this train of reasoning, when striking examples in point will be brought under notice.

Throughout this inquiry we have attempted to prove, that hair, for example, both in man and the lower animals, is found in great abundance in certain superficial localities only ;—that these are always distinguished by a large amount of nervous matter ; and moreover are centres of excited action, far greater in degree than is common to other parts of the cutaneous surface.

The vital processes of the brain in many animals which do not ruminate ;—processes that do not indicate the existence of any particular point of cerebral activity, occasion the emission of chemical substances which appear in the greater or less profusion of hair on the head. We may, nevertheless, conceive such a centre to exist, as in the case of the ruminantia ; and, agreeably to a law of the animal system, substances will have to be thrown off from the aroused tissue, according to its organic requirements. If these are much greater than in any other class of quadrupeds, exigencies will arise for the growth of peculiar supplementary structures, the situation and character of which will be the expression of the concentrated and vigorous operations of the region in question. Hence the development of horns. The situation these occupy, exactly corresponds with that part of the brain which is particularly excited by the act of rumination.

There are other considerations which press upon our attention. Animals which masticate their food only once, produce very limited changes in it. In most instances, it is merely crushed or broken down, and, at times, scarcely

either, previous to its being conveyed into the stomach. From the rapidity with which this is usually accomplished, the saliva mixed with it is comparatively small in quantity. The digestive organs have, therefore, to labour to a proportionate extent in the conversion of it into chyle. The demands which the successive stages of the process create, are indicated by the disposition of the carnivora, and of the indolent of the human race, to sleep after a substantial meal. This is a necessity of the system. The blood and nervous energy flow where they are required ; and the presence of food in the stomach, gives them a direction towards the abdominal viscera, leaving a diminished amount for other vital operations.

In the ruminating animal, the mouth and its associated organs perform a large proportion of the duties, which would otherwise have to be effected by the digestive apparatus. They do a great part of the rough work, which, under other circumstances, is thrown upon the stomach ; consequently their functions may be regarded as two-fold,—to masticate and digest ; implying by the latter, the reduction of the food into a pulpy state, and its thorough admixture with the saliva, by which the process of digestion is very greatly facilitated.

It requires no profound acquaintance with physiology clearly to apprehend, that the peculiarities here alluded to, in the two classes of animals, with respect to the influences to which food is subjected, will give rise to very dissimilar nervous and circulatory conditions. In the ruminant, there is not the same concentration of nervous power in the digestive organs ; nor is it required, as in animals possessing

only one stomach, and receiving food imperfectly acted upon by mastication. In the ratio of the difference, *is the greater activity of the brain in relation to the organs of taste, and of structures co-operating in the chewing of the cud.*

On what grounds is it possible to question the accuracy of this line of argument or the facts on which it is based? It is evident, that rumination acts in a manner which is equivalent to taking a portion of nervous energy from the stomach, and imparting it to the organs exercising the elaborate functions of mastication.

The mouth and brain, in this case, *become excited and persistent centres of vital operations*; and hence the growth of horns which generally distinguish the ruminantia.

It may probably be asked: what is the advantage of researches of this kind? Whatever widens the boundaries of human knowledge, enlarges the sphere of human enjoyment. Mankind are too prone to measure the value of scientific discoveries by the evidence of their immediate utility, which is often to estimate them unjustly. Genius attains to new and higher points of view; but time and the reiterated efforts of the human mind, are necessary to bring out the riches with which they may be pregnant. Nor do they ordinarily yield these freely, until advances in other branches of science have extended and elevated the researches of the philosophical inquirer. An important truth is utility in some form. It is practical to some end. It subserves some purpose of human happiness.

In treating of the structural and functional causes of the growth of particular appendages, we are simply tracing the means which nature employs in the production of remark-

able effects ; showing the connexion which exists between the development of an external organic substance, and the local and general conditions of the animal system in which it originates. To the attainment of this object our labours are directed. It is, however, clear that they overleap these precise limits : nor is it possible to investigate with attention any part of the bodily structures, studying it in its active functional relations to others, without being led into a larger field of research than was contemplated, and embracing more or less the whole of the animal economy.

If the principles we have anxiously studied to develop, have no foundation in nature, being merely ingenious speculations ; is it not a singular, if not a marvellous coincidence, that the different appendages appear under the conditions which the principles exact and specify, and in connexion with none other ?

In elucidation of the views brought forward, we proceed to make a few remarks on the ruminants possessing horns. In the greater part of them these structures are permanent, as in oxen, sheep, goats, antelopes, and the giraffe. In others they are shed annually. The cause of these differences will, in our opinion, be found to depend on constitutional circumstances by no means difficult to define ; and the explanation will tend to corroborate the justness of the views brought forward.

One striking discrepancy between animals which shed, and those which retain their horns, *is in the vigour of the animal system, in the former, and the singular changes to which it is periodically subject.*

We will endeavour to render this intelligible by reference

to oxen and sheep, on the one hand; and stags on the other. The former, in a domestic state, are dull, docile, or inoffensive in disposition. The male does not display to any great extent an impetuosity of feeling, at the season, when the appetite, the most ungovernable of the passions, is roused by the occasions which gratify it. The animal exhibits a certain degree of excitement, but the phenomena to which it gives rise, are very different from what occur in the other class of animals. The body, previous to the stage of excitement, is not brought into a state of extraordinary vigour, awakening an intense sensual impulse peculiar in the manifestations of its violence; nor is it, at the close of this temporary season, reduced to a lean, depressed, and miserable condition.

The domestic ruminants are not subject to these extremes of the animal system, one of which, in the stag, necessitates the development of horns, and the other the shedding of them. The exuberant vigour of the vital powers is the cause of their growth; and the remarkable constitutional weakness which follows, being unequal to the maintenance of them, is the occasion of their falling off.

Oxen and sheep retain their horns, the animal system being distinguished by a certain evenness or equability of vital action,—a degree of sobriety which is only slightly disturbed at the season alluded to.

The differences, between the several classes of the ruminantia, in the condition of the functions of life, and the changes they undergo, will satisfactorily account for the persistence of horns in some, and the annual shedding of them in others.

Among stags, with the exception of the rein-deer, the

male alone possesses antlers, varying greatly in size and form in the several species, and in individuals of the same species; in the latter instance showing, that the degree in which they are thrown out is in relation to constitutional requirements, and accurately indicates the prevailing state of the vital powers. Differences of this kind go far to establish the correctness of the principles advanced. They imply a greater or less amount of superfluous elements which have to be disposed of, and the growth of the antlers is one of the means which nature has provided.

At the season, when the amative propensity is roused, the stag is combative, restless, and bellows throughout the night. The phenomena which he exhibits, *are observed only on the completion of the development of the antlers*, nature having no longer an issue in the formation of them. The cessation of the vital processes, in the direction of the external region, is the occasion of the vigorous activity of the generative organs. These become a new outlet in relation to the system, which is thoroughly relieved by the inordinate indulgence of the sensual propensity. The debility and exhaustion which follow, are the cause of the antlers being shed, the constitution being unequal to the support of them.

When we treat of the influence of the generative system in the lower animals, we shall enter at greater length into the consideration of this subject.

The train of reasoning which is here pursued may be further illustrated, and the justness of it confirmed by singular and indisputable facts.

A few solitary instances are recorded in which the female

roe had antlers. One of these is peculiarly valuable in its bearing on these researches, the causes of their development being clearly ascertained. The animal, in this case, had only a single horn, and on dissection the *ovary* of the same side was found to be schirrous.* The disease, which to this extent, destroyed the influence of the sexual organs on the female constitution, allowed this to assume proportionately the attributes of the male; and, therefore, the production of the external appendage. Similar facts have presented themselves in connexion with woman giving rise to the growth of a beard.

Phenomena, so strange, and altogether out of the ordinary course of nature, would appear designed for our instruction. They speak a language which admits only of one interpretation.

The disease of the ovary, in this, and in other cases of the kind, arrests or enfeebles the normal actions of the sexual organs of the female, by which the vital energies are drawn from without, inwards, creating a dominant internal centre. The blood and nervous power, that would otherwise have contributed to important ends, in relation to these organs, being no longer controlled by the influence of the latter, are set at liberty, or freed from their internal engagements; in consequence of which they are appropriated to the general purposes of the animal system, and we have evidence of it in the increased bodily vigour which results. What does this imply? Greater vital actions throughout the cutaneous surface, and proportionately more abundant matters to be emitted from some region of it. The channel which

* Lin. Trans., vol. ii. p. 356.

nature selects for the escape of them, in the instance under consideration, is the development of a horny appendage on the head. This, in its majestic amplitude, is characteristic of the male only, and we have no traces of it in the healthy constitutional states of the other sex. When, however, the animal system, in the latter, is so influenced as to lose feminine and acquire masculine properties, it relieves itself of its useless elements by a production foreign to the female; viz.: antlers.

Is there any structural condition of the cranium, connected with the growth of these appendages, that did not originally belong to the organization of the female? Certainly not. The several tissues composing the head of both sexes, are clearly precisely the same, though one of these is invariably endowed with magnificent antlers, and the other altogether destitute of them.

Would it not be reasonable to conceive, that the evolution of them would require a peculiarity of structure, faintly, if at all, possessed by the weaker sex? Such, however, is not the case. Rumination is common to both, and affects the cerebrum of each in the same manner; but is not accompanied by the same results,—simply because the vital materials of the circulating fluid, and the mode of their distribution, do not equally necessitate an outlet. In the female, we have no evidence, from the absence of the supplementary organs, that the upper and posterior part of the brain is a centre of extraordinary activity. But when disease, rendering useless those organs on which her fruitfulness and feminine character depend, so modifies the constitution, that this assumes the qualities of the male,

it is then that the cerebral region, excited by rumination, becomes the point to which the superabundant matters are directed, and it is there that they find an issue in the growth of horns.

This case is exceedingly important in two respects: in the first place, it shows the nature of the difference in the vital powers of the two sexes, and the causes in which it originates. The line which separates them, is the greater constitutional vigour in the one than the other, and the presence of waste elements in a corresponding degree, created and transmitted from within, outwards.

The other matter, which merits particular attention, is the situation where the external appendages appear. Were it not for special organic effects produced in the brain by rumination, there would be no more ground for supposing that antlers would grow on the head of the female roe, than on any other part of the body; or, in fact, than on the head of the lion. The greater analogy between the two sexes, of the same species, than between one of these and an animal different in form and habits, will not account for the development of horns, in the instance alluded to, *if the agency of rumination be excluded*.

The growth of them, in the female, is not in the scheme of nature, any more than a luxuriant beard and whiskers are on the face of woman. The local cause which determined the production of a single antler, is to be found only in the influence exercised by rumination on the brain, conjoined with the altered properties of the blood and of the nervous system.

We are tempted, from the deep interest which attaches to

the subject, to make a few further remarks in support of the line of argument which is here pursued. In a previous part of this inquiry we have stated, that disease of the ovaries, in the human female, has at times been succeeded by the growth of hair on the face, in quantity not inferior to what is natural to the robust male. We may ask: why does it show itself in this situation? If the disposal of useless elements was regulated by no established principles, and on the present occasion easy of explanation, a profusion of hair would be as likely to occur on the abdomen or haunches of the female, as on the face. The appearance of it here is not a matter of chance: the structures and actions of the region are the same, differing only in degree, in both sexes. When the female system has, however, superfluous matters to throw off from disease of the uterine organs, they have an issue in the face,—*in consequence of the predominant vital operations which are peculiar to it*,—operations which do not exist to an equal extent in any other superficial locality. The natural conditions of the region, invigorated by the constitutional changes induced, occasion the growth of the beard in woman; as those of the brain, arising from the same general causes, and aided by rumination, do that of the antlers in the female roe.

Ruminants of the same species, in a wild and domesticated state, differ greatly in the size of the external appendages. Wandering at large in the trackless domains of nature, the body is powerfully influenced by the circumstances in which it is placed: it is roused to extraordinary activity, and displays a strength, vigour, and freedom of action, which have little in common with the prevailing en-

dowments of the domestic animal. There is evidence of this fact in the supplementary structures thrown out on the cutaneous surface. Life riots in the affluent currents transmitted from within, outwards; and it indicates its riches by the creation of magnificent horns, antlers, and flowing manes. These express in intelligible forms the character of the constitutional necessities by which they are developed.

What inference are we entitled to draw from these phenomena in reference to the principles of this inquiry? Is it not clear that the appendage, whatever may be its nature, is the result of chemical elements which the system is forced to dispose of from the several regions of the body according to their local requirements? In a wild state, the animal, from superior constitutional vigour, has a greater abundance of them to emit; consequently the supplementary structures are proportionately evolved. The justness of the reasoning will scarcely be questioned.

One of the ruminants, the *antelope gnu*, deserves particular notice. It seems a compound of different animals. It has the body and crupper of the horse, is covered with brown hair, and the tail, which resembles that of a horse, is furnished with long white hairs. On the neck it has a beautiful and ample mane, and the same under the throat and dewlap. The muzzle is large, flat, and surrounded by a circle of projecting hairs. It has two horns which at the base approximate, but descend outwardly, and turn up at the point.*

In this example, we perceive what nature in a wild and

* The Animal Kingdom, by Baron George Cuvier; with Additions, by W. B. Carpenter, M.D., F.R.S., and J. O. Westwood, F.L.S. P. 141.

savage state is capable of producing. The circumstances influencing the animal are eminently favourable to its organization. Hence the strange and marvellous endowments by which it is distinguished.

When the male and female ruminants equally possess horns, these differ in form, size, or solidity of structure, and occasionally in a remarkable degree, unequivocally manifesting the differences of constitutional vigour.

The ruminants differ greatly in the character and structure of their horns. In some they are hollow, as in the ox, sheep, goat, chamois, gazelle, and antelope. In others they are solid, as in the stag, elk, and rein-deer. The constitution of the animals not only necessitates, but reflects these differences. How quiet and docile are the one class as compared with the other, and particularly at those seasons which mark the completion of the antlers! The vital powers concerned in the creation of these, are far more vigorous than in those in whom the horns are persistent and hollow.

From fossil remains it appears that ruminants formerly existed possessing gigantic proportions. The cranium and other bones of one have been discovered, which show that the animal was twice the size of a large ox. It was four-horned; and, at the present day, we have the same or an allied species with an equal number of horns, but in every respect greatly inferior to its predecessors.

From this and other facts of the same kind, it would appear, that at remote periods, beyond historical records, animal life was very different from what it is at present. The structural forms were on a much larger scale, and the

appendages were either more numerous or of greater magnitude.

An interesting class of ruminants with which all are familiar, are the sheep of our own country, the varieties of which are numerous and worthy of investigation. They differ greatly in form, in size, and in the productiveness of wool. Particular care has for many years been bestowed in the breeding of them, in the attempt to attain three objects : a large development of the body, the speedy fattening of it, and a copious growth of wool. The efforts made have been crowned with remarkable success.

It would indeed be singular, were not the animals which possess these qualities in a high degree, as a rule, *destitute* of horns,—as the Lincolnshire, the Leicester, and the Cotswolds ; while horns are present in others which have not been forced into these unnatural conditions, as the black-faced Scotch, the Exmoor, the Dorset, and the greater part of the Radnor and Welsh sheep.

The differences between these two classes of animals are peculiarly striking. Yearlings of the Lincolnshire breed, weigh from 80 to 100 lbs. ; the Cotswolds, in twelve or fifteen months, 100 lbs. ; and those of the Leicester have likewise an aptitude for fattening : at two years of age they will reach 150 lbs. The horned sheep, on the other hand, scarcely attain half these weights. The black-faced Scotch, at three years barely average 65 lbs. ; the Exmoor, fattened at the fourth or fifth year, range from 60 to 70 lbs. ; and the Welsh, at the same period, are from 30 to 40 lbs.

These differences are connected with important physiological considerations. The creation of fat to the extent

above indicated, is an unnatural state of the body,—a result that would not occur except from the well-directed culture of man. He so changes the *temperament* of the animal, that its light, active, and hardy character altogether disappears. The nervous and muscular endowments which confer upon it these properties, are thoroughly modified. His calculation and care are to effect these ends by the alteration induced in the vital functions of the animal. The nervo-muscular constitution is converted into the *lymphatic*, the disposition of which is, under favourable circumstances, to secrete fat. The presence of this is in perfect accordance with the state of the vital powers, its production being one of the means which the system is forced to adopt, in order to get quit of the carbonaceous and other elements in excess, resulting from the food and habits of the animal. *The formation of fat is the disposal of matters that would, under other conditions, create horns.*

There are other facts bearing on these researches not unworthy of notice. Some of the animals which are destitute of horns, have strong tufts of wool covering the forehead. This is observed in the Cotswolds, and in a lesser degree in the sheep found in the Romney Marshes. They are more prominent in the male than female, which is another illustration of the influence of the generative system.

These tufts are significant of a state of the constitution, different from that of animals which possess neither kind of appendage. The body has probably completed the transition stage from horns to tufts.

It may further be remarked, and the fact is strongly corroborative of the justness of the views advocated, that the

presence of horns indicates a *hardy* race of sheep, and is admitted by writers familiar with the subject: the vital qualities it implies, are evidence of a predominance of nervous and muscular endowments. It is the combination of these which imparts bodily activity, tone, and hardness of constitution, and necessitates the development of horns.

A singular organic condition is observed in one of the varieties in connexion with the existence of horns. In the black-faced Scotch sheep, the wool is intermixed with hair. The growth of the latter requires far greater vital energy than is required for that of the former. The one may luxuriantly grow on fat: the other, to be thrown out in the strong form in which it appears, must have a very different substratum, and in association with vital properties distinguished by uncommon vigour.

In a subsequent part of this inquiry we shall enter more, at length, into the consideration of the causes influencing the production of fat, wool, and hair. The facts brought forward, to be studied with advantage or to be justly appreciated, must be examined under other aspects, and in connexion with other phenomena with which they are inseparably blended.

The remarks which are here made in reference to sheep, pointing out the circumstances on which the growth of horns depends, are strengthened by what we perceive in other cattle domesticated and usually horned, as the cow, ox, and bull. The supplementary organs in these vary in size and form, according to the vigour of the animal system. They are modified in these respects by every change induced in it, whether intentionally or otherwise.

In the *long-horned* or Lancashire breed, we have evidence of the robustness of the powers of life in their external endowments. The hide is thick and firm in its texture,—the hair long and close, the neck strong, coarse, and leathery, and the horns proportionately large,—circumstances establishing the hardiness of the constitutional qualities.

The animal attains to no great weight. In this respect it is greatly inferior to the short-horned, and gives far less milk,—a fact which is equally significant of the prevailing bodily conditions. The vital energies are thrown to too great an extent on the cutaneous surface, appropriating elements to the production of affluent appendages, to promote an abundant secretion of milk.

In the *short-horned*, of which there are several varieties, the head, neck, and bone are fine,—the hide is extremely thin, the carcase large and well-fashioned, the flesh excellent in quality, and the animal is readily fattened; and as might legitimately be inferred from the aggregate of these properties, yields a greater quantity of milk than those of any other breed.

The facility with which the adipose tissue is developed, is a measure, and a just one, if applied to a race, of the capabilities of the animal to afford the lactiferous secretion. They both indicate a state of the blood abounding in carbonaceous matters, not at all adapted to the formation of *vigorous* structural endowments. Their natural, and indeed their only issue is in the production of fat or of milk. A predominance of the one is at the expense of the other.

In studying the *middle-horned* breeds, of the varieties of

which the most noted are the Devon, the Sussex, and the Hereford, we have a striking confirmation of the force of the foregoing observations. The qualities by which they are distinguished, are an approximation to the short-horned. This would be calculated upon from the thinness of their hides, the fineness of their bone and hair, and the clearness of their neck and head,—conditions in perfect accordance with the character of the horns. The exterior of the animals indicates their disposition to fatten, and their ability to give milk; though in an inferior degree to the short-horned. The Hereford variety makes the nearest approach to the latter.

We have a further exemplification of the soundness of these views in the Alderney cattle. They are small in size, fine in bone, delicate of constitution, and have short crumpled horns. The milk which they yield is not great in amount, *but peculiarly rich*.

Among the *polled or hornless breeds* we may mention the Galloway variety. With full feeding they soon attain maturity, and their flesh is of the finest quality. It is stated that they were formerly *horned*, and in external appearance and character like the black cattle which then prevailed in the west of Scotland; but being coupled with hornless bulls, the constitutional change effected, *while it greatly increased their size*, was accompanied by the loss of horns. In alluding to several varieties of sheep, it was stated that the care bestowed in the breeding of them, to secure greater bulk and superior fattening properties, was attended by the same remarkable result.

It would be easy to extend these observations, but it is not

necessary for the elucidation of the general scope of this inquiry. From the facts brought forward, it is clear that some of the most striking of the supplementary organs of the animal body, are thrown out, influenced in form and size, or altogether disappear, according to the state of the constitution.

Rumination, as we have laboured to show, is the cause, under particular conditions, of the growth of horns, the excited and persistent action of the brain furnishing an issue for the escape of superfluous matters. If these, however, from the character of the animal system, do not exist,—that is, if they are not present to an extent to require an outlet of the kind here contemplated, the appendages will not be developed, as is the case with several of the ruminantia.

The camel, lama, and musk deer, are destitute of horns; and, therefore, they may be urged as objections to the principles brought forward. If, however, these be justly apprehended in their scope and bearing, the absence of the structures in question, so far from militating against the accuracy of them, will be additional evidence of their general truthfulness.

We will first study the camel, of which there are two species: the one-humped and the two-humped animal. The remarks we shall offer will apply to both. Their long neck, projecting orbits, weakness of the crupper, and the strange proportions of their legs and feet, give to their appearance a sort of deformity. In disposition they are extremely mild and docile. Though capable of performing long journeys, under exceedingly unfavourable circumstances, their temperament is clearly not distinguished by properties

indicative of a vigorous state of the powers of life. They are admirable examples of the contrary, and to a degree from which we may legitimately infer the inability of the system to produce horns. Of the accuracy of this opinion, we have evidence in the presence of the hump or humps, the nature of which is fat. The growth of this in any region of the body, and in this instance especially, as a natural appendage, *clearly demonstrates the low state of vital action which exists*. It places the fact beyond dispute. The fat is a provision of superabundant nutriment, and is gradually absorbed and disappears when the animal suffers from a scarcity of food.

The absence of horns is not only in perfect accordance with the constitution of the animal, but the presence of them would have furnished a very serious objection to the principles laid down. We should have had the growth of them in connexion with vital functions, which we have endeavoured to show throughout these researches, are inadequate to their production.

In discussing the varieties of sheep, we found that the attention bestowed in the breeding of them, to secure great bulk or an abundance of fat, gives rise to constitutional conditions incapable of the development of horns. The luxuriant growth of these, and the copious secretion of fat, either as a natural appendage, or originating in the aptitude of the animal to form it generally throughout the body, express extreme states of the vital powers;—states antagonistic in their influence, and in the structural effects by which they are characterized.

Another exception among the ruminantia, in which

horns are absent, is the musk-deer. It is remarkable for its elegance and lightness. The pouched species is the animal which yields the musk. The secretion of this singular odoriferous substance, adds another to the numerous examples which crowd upon the mind, displaying the influence of the organs of generation. The male alone produces it. Reasoning on the principles advocated, the pouch, in which it is formed, is obviously an extraordinary vital centre, and offers an issue for the escape of chemical elements, which are disposed of in the secretion of musk. This, according to the explanation given of the office of appendages, or the end to which they are subservient in relation to the animal economy, is clearly of the same character. Probably no animal possesses two different kinds of supplementary structures. Horn, hair, and ivory, whether in the form of horns, manes, or tusks, are similar in constitution; and the co-existence of them in the same animal is not at variance with the foregoing remark. The musk-pouch has little in common with these; yet it is equally a centre of excited operations, and an outlet for the escape of superabundant matters. On these views we conceive the absence of horns is satisfactorily accounted for.

The last ruminant we have to notice, destitute of horns, is the lama, which, in its organization and the uses to which the animal is applied, approximates somewhat to the camel. It has no humps; but it is alleged, on the authority of Molina, to possess considerable fat under the skin, serving the same purpose as the humps, when the animal suffers from an insufficiency of food. Whether this be a fact or not, is for the naturalist to determine. If such be the case, it is evident that the temperament of the animal is wanting in

those qualities which occasion the growth of horns. The presence of fat in any region of the body, regarding it in the light of an appendage, will explain the absence of the external endowments which distinguish the ruminantia.

It is not needful to pursue this subject further. We have treated of it at considerable length; and felt impelled to do so from the novelty of the views in reference to the process of rumination. This has not hitherto been studied by any writer in its effects on the brain. We were led to the investigation of it from the numerous facts which presented themselves, showing that particular appendages were developed only in regions which were the predominant vital centres of the system.

In treating of the few ruminants destitute of horns, it will scarcely be doubted that, according to the views we have studied to develop, the absence of them is strictly in accordance with prevailing constitutional conditions, these being inadequate to their production. The accuracy of this conclusion is, in our opinion, demonstrated by the phenomena observed in the breeding of sheep. The attention given to them, as previously stated, to secure greater bulk, and a facile development of abundant fat, so modifying the constitution of the animal, that it is unequal to the growth of horns.

CHAPTER XI.

CAUSES OF THE DEVELOPMENT OF TUSKS IN THE LARGER
QUADRUPEDS.

WE now enter upon the consideration of a description of appendages, in form, situation, and character, very different from those of which we have already treated. We allude to the tusks of the elephant and the horns of the rhinoceros. Writers, in attempting to account for these and analogous external structures, appear to satisfy themselves and their readers with the remark, that they have been given for the purpose of self-defence, or to enable the animal to combat with greater advantage ;—a doctrine which it is difficult to accept, as an exposition of the ends to which they are subservient. Nature, in this point of view, is extremely partial in the distribution of her gifts. It may be very well for the eagle and hawk to possess talons ; but we must not forget, that these endowments are terrible in their effects upon a less-favoured portion of creation. We have, on the one hand, the implements of destruction ruthlessly exercised ; and, on the other, the helpless and unresisting victims.

We do not presume to fathom the designs which have

given rise to these diversities of animal being. The attempt would be futile and ridiculous. We take creation as it exists, or has existed, as far as we can accurately, or indeed obscurely, trace the early stages of it.

On the views we have studied to develope, we have been led to regard the presence of particular external appendages, as results necessarily arising from certain local vital conditions, and so connected with the general organization of the body, as to display in an unmistakeable manner the influence which the one exerts upon the other.

Previous to discussing the causes of the growth of tusks, we shall make a few remarks, in order clearly to define the difference between *supplementary* structures, and the *permanent* or essential organs of the animal; or so slightly modified by circumstances falling within the sphere of actual observation, as justly to be considered in this light. It can scarcely be doubted, that many of the organs of the latter class were, in an earlier stage of animal organization, supplementary, or were very different from what they are at present; and were gradually evolved through the agency of external causes influencing the tissues of the body generally.

The animal creation presents, under a variety of forms, structures to which it is not easy, according to prevailing ideas, to assign any definite utility. Hence they have been regarded as ornamental, or contributing to some end of questionable importance. The whole of this class of organs are, in general terms, *supplementary*; and are so variable in the degree in which they are thrown out, that in individuals of the same species, we observe the most extraordinary discre-

pancies. In some they are magnificently developed; while in others, if not altogether, are comparatively absent.

If they have any utility, we may ask: in what does it consist? If for ornament, or to gratify pugnacious propensities, why are they not the common property of animals of the same species? It is not possible to answer the question satisfactorily on received opinions;—on the physiological principles laid down it is not difficult. The presence and absence of the organs, and the modifications of which they are susceptible, are evidence of constitutional differences, implying greater or less vigour of the powers of life, originating in the influence of climate, using the term in its most comprehensive sense.

The elephant will enable us to place, in a strong point of view, the distinction between supplementary and essential organs; and the facts which the investigation will elicit, will tend to corroborate in a striking degree the correctness of the principles advocated.

There is only one living genus of the elephant, which is found in great numbers in Asia and Africa. The animals differ greatly in external appearance in the two regions. In the Asiatic, the male and female have only occasionally ivory tusks. They have what are designated *tushes*, from nine to eighteen inches in length. It is stated, on unquestionable authority,* that when the animal has the well-

* I have great pleasure in being allowed to publish the following letter from a gentleman, who speaks on the subject from extensive personal observation; nor can I sufficiently express my thanks to him, for the courtesy and kindness with which he has replied to my questions, or the interest he has taken in these researches:—

“*Chelsea, Feb. 13, 1856.*

“DEAR SIR,—In reply to your inquiries respecting elephants, I beg to

developed tusks, it is invariably the male. This fact is important, as it shows that a certain state of the system is essential to the luxuriant growth of the appendages; and, in this instance, the vigour indicated is mainly due to the influence of the organs of generation.

The tusks, like the copious beard in man,—the flowing mane in the lion,—and the exuberant hair on the neck and fetlocks of the horse,—establish in the locality in which they originate the presence of surplus chemical elements; and the splendid ivory structures into which these are fashioned, *are an accurate measure of the existing exigencies of the animal system.*

The African species is an extremely vigorous animal, and, as a natural consequence, both sexes very largely possess well-developed tusks. They are, however, of greater magnitude in the male than female.

After these brief considerations we may ask: of what use are these supplementary structures? If to combat, why are they withheld from a great portion of these animals in one region, and abundantly given to others in a different part of

inform you, that in Ceylon not more than one in 100 or 150 is provided with ivory tusks, and that one, *as far as my experience goes*, invariably a male. The others have long excrescences called *tushes*, from nine to eighteen inches long, and six or seven inches in circumference where broadest. The tushes are of little or no value.

“In Northern India, the female elephant sometimes, though rarely, is provided with tusks. These, however, are invariably much smaller than those of the male.

“Mr Gordon Cumming, the celebrated African hunter, informs me that both male and female elephants have tusks in Southern Africa, ‘with very few exceptions, probably owing to injury in early life.’ I am inclined to think, however, that the rule is universal, that where the female is so furnished, her tusks are much smaller than those of the male.—I am, Sir, yours very truly,

“WILLIAM KNIGHTON.”

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the world? That this was the end they were intended to serve, is an opinion which scarcely merits a passing remark. They are frequently of such immense size as to be a burden and a serious inconvenience to the animal.

They have clearly no utility, in relation to the body, as interpreted by writers. Were they instrumental to the accomplishment of some particular object, they would not be the endowments of a few, but of all. Whatever displays this character, with respect to external or internal structures, is the common property of individuals of the same genus. The tusks cannot be regarded in this light. In the Asiatic species, so far from being universal, they are only occasionally present. It is, therefore, evident that they are organs to which the term *essential* cannot be applied: it may, indeed, to the proboscis, as this is never wanting.

The elephant is mild and docile in disposition. It is not often attacked by other animals; nor is it prone to be the aggressor; and, therefore, it is reasonable to infer, that the utility of tusks is not explicable on the views which have hitherto been entertained. The development of them depends on the structural and functional conditions of contiguous and important tissues; and is an inevitable effect in connexion *with particular states of the animal system*. If this has no useless matters to dispose of, the incessant and extraordinary muscular movements of the proboscis, will not occasion the growth of magnificent ivory appendages. When these are present, they indicate the urgency of local necessities in relation to the body generally.

The tissues from which they arise are the seat of concentrated and vigorous vital actions; and, in reference to the

animal economy, *are a species of safety valve*. Through them elements are expelled according to imperative constitutional requirements. If from the influence of climate, food, and other causes, matters of this kind are not abundantly produced, tusks will not be observed, or only to an insignificant extent. They owe their development to a predominance of the senses of touch and smell, conjointly with the muscular motions with which the exercise of these are accompanied. Had there been no proboscis, there would have been no imposing supplementary appendages. The former creates the latter.

Whatever animal possesses tusks, variable of course in size, has structures analogous to the proboscis, in connexion with an extraordinary acuteness of the two senses in question; the activity of which brings powerfully into play the snout or an elongated lip, which is the trunk on a less scale. The rhinoceros is a familiar example. The whole of the hog species is another. Among the latter we have a singular illustration in the babyroussa, which has two slender tusks shooting out from each jaw. Those of the upper are half-a-yard in length. It has been stated, with what truth we leave others to determine, that the animal when disposed to sleep, suspends itself by them from branches of trees. Paley alludes to the circumstance as evidence of design. Of the habits of the animal little is satisfactorily known. In the conformation of its head and snout it has the characteristics of the swine species. The accounts concerning the acuteness of its sense of smell border somewhat on the marvellous.

It would be foreign to this inquiry to discuss the reasoning powers, the sagacity, or usefulness of the elephant. The

faculties by which it is distinguished, and in a high degree, are its sense of touch and of smell. The former is displayed in the wonderful endowments of the proboscis ; and the latter in the capacious organs of olfaction. The trunk and the tusks originate in contiguous structures ; and if we contemplate the vast amount of nervous matter distributed to them, it is obvious *that they are the seat of the predominant vital actions of the body*. It is in them that life displays itself in the affluence of its energies.

The sensibility and muscular powers of the proboscis require no illustration. But what do they imply ? The existence of nervous substance throughout its structure agreeably to the capacity of its functions. At the base of the organ are the nerves which impart to it nervous energy, in virtue of which it is enabled to exercise its vital and physical properties. The region where these nerves accumulate, previous to their distribution in the trunk, *is an unparalleled centre of vital operations*. The animal kingdom offers no example at all equal to it, in respect of the vigorous processes carried on in those parts whence the proboscis arises. Every movement of the organ, and it is in constant play, arouses in a remarkable degree the tissues with which it is directly connected ; and, according to a law which we have endeavoured to establish, in particular conditions of the animal system which have been specified, elements have to be thrown out in some structural form, in the ratio of the local vital actions which exist. Hence the growth of those singular, cumbersome, useless, and extraordinary productions,—the tusks, which have been known to attain nearly ten feet in length.

It is scarcely needful to urge, that the development of them, in this situation, is in perfect accordance with the physiological principles laid down. If an appendage, in one instance, whether the beard and whiskers in man,—the mane in the horse and lion,—and horns in the ruminantia, is the result of excited and concentrated vital actions in the locality where it appears,—the creation of it being the appropriation of matters emitted as a relief to the tissues by which it is evolved ; it is equally imperative on the animal economy, in every other case, to exhibit the same organic necessity. It is a law impressed on animal and vegetable matter, and in both is the occasion of the diversity of aspects by which they are distinguished.

The tusks are simply the horns of the animal occupying a position which is determined by the presence of the proboscis. They appear where they are wanted, and in no other region, in exquisite agreement with local and constitutional exigencies. They are neither for ornament nor use, as this is ordinarily understood. They are indeed evidence, and an admirable illustration, of the despotic influence which one organ exercises in the production of another : and were we more profoundly acquainted with the principles regulating the development of organic structures, we should discover numerous examples pointing to the same end.

On the views which we have laboured to establish, one organ occasions the growth of another *for its own preservation and well-being*. The one is essential to the existence of the animal : the other is superfluous ; but in certain conditions of the body is an indispensable accompaniment, the formation of it being the appropriation of matters, which

could not otherwise have been emitted from the region where the essential organ is located. The growth of the appendage, whatever be the character of it, is a necessity originating in the vital operations of the tissues from which it is thrown out.

The tusks are not observed in the young elephant until about the third year. The body, in its successive stages of progress, has no useless elements to expend in the production of supplementary organs. The currents of life are only beginning to be drawn from within, outward; creating in the direction of the latter vigorous processes expressive of the fact. The proboscis has not yet been exercised to an extent, to make the tissues with which it is connected a centre of extraordinary activity. When this occurs, and the animal system displays robust qualities, the tusks grow, but the first which are formed are shed. They are subsequently persistent.

From these considerations it is not difficult to understand the causes of the differences between the existing species; or the peculiarities which individuals of the same species exhibit. In the Asiatic, *tushes* largely take the place of tusks. The latter are not common even in the males. But when present, and in a remarkable form, it is only among the more vigorous of the male sex. This animal is clearly inferior in constitutional endowments to the African; as is shown by the shape of the head, the length of the ears, and the magnificent tusks generally found in the latter. The animal system has not the same organic necessities in the two regions, from causes which are to be traced to the influence of climate. Hence in the one species, the ample

ivory appendages are rather the exception than the rule; while in the other they are very largely possessed by both sexes.

The development of *tushes* in place of tusks is equally favourable to the principles advanced. It indicates a comparatively low state of the constitution; a less amount of surplus elements is created; and hence the supplementary structures into which they are formed are proportionately diminutive.

The body of the elephant is covered with a rough skin, and, in general terms, is destitute of hair, which in our opinion is an extremely interesting and important circumstance. Had the animal been distinguished by higher vital qualities, the production of the tusks would not have furnished a sufficient outlet for the matters which would have to be expelled. The few hairs which exist show, that had the organic requirements been greater than prevail in either species, *the cutaneous surface would have possessed a luxuriant crop of hair*. We arrive at this conclusion from a knowledge of the conditions which occasion the growth of it; and it is not less singular, than a remarkable corroboration of the justness of the train of reasoning pursued, that an elephant, regarded as belonging to an extinct species, has been discovered entire, the body of which was clothed with exceedingly thick, long hair; and besides, was adorned with a large flowing mane. The hair which had fallen from it, and been trodden upon the ground, by those who first found the carcase, weighed 36 lbs.

These facts are peculiarly valuable in connexion with the physiological principles brought forward, explanatory of the

causes occasioning the development of supplementary structures; the degree in which these are thrown out being strictly in accordance with constitutional exigencies, variable in the demands which they make according to the influence of external circumstances.

The facts here stated, in reference to the elephant in question, will suggest further remarks concerning it. It was discovered in 1799, near the mouth of the river Lena, in Eastern Siberia. The structural peculiarities it presented, as compared with the elephants of our own day, scarcely warrant naturalists in describing it as a separate species;—no more than the strong bristles, intermixed with short frizzled wool, in the hog of the same regions, mark it out as a species distinct from the swine of our own country. In the latter instance, the differences between the two, are simply evidence of the influence exercised by external causes on animal organization.

The same observations apply with equal force to the Lena and existing elephant. The body was not only clothed with long, black hair, but had likewise, in great profusion, a red kind of fur or wool,—and, in addition, the neck was graced with an imposing mane. It is stated that the laminae of the molar teeth are more numerous than in those of the Indian elephant. These are the principal structural differences which it offers; and, as already observed, they are scarcely of sufficient value to induce us to consider it as an extinct species. When we take into account the effects of climate on the functions and structures of the body throughout the animal creation, discrepancies of this kind are certainly easy of explanation. The animal was of the male sex, and

to this is probably to be ascribed the presence of the luxuriant mane.

The discovery of this elephant has given rise to various conjectures, in the attempt to assign a satisfactory reason for its appearance in these extremely cold regions, where probably for thousands of years it had been imbedded in ice. By some it is supposed to have been transported from a tropical climate: others conceive it to have been a native of the country where it is found, which, however, had undergone a change from a torrid to a frigid temperature. According to a third hypothesis, it is urged that the animal was adapted to a cold region, and unfitted to dwell in the torrid zone, and from causes eluding the investigations of man, has become extinct.

It is not our intention to analyse the degree of probability which these several speculations possess. This has been done by a writer admirably qualified for the task.* The opinions we shall hazard will be such as are suggested by physiological considerations.

It is difficult to imagine on what grounds it can be doubted, that the elephant was a native of the country where it was found. An immense number of fossil bones of huge animals have been discovered north of Siberia, and throughout extensive tracts of the northern parts of Russia; as, for example, those of the elephant, rhinoceros, buffalo, hippopotamus, and tapir. These now inhospitable regions were clearly the abode of the animals in question; admitting the fact, which it is certainly not easy to rebut, does it not follow that the climate had a very different temperature from what

* See an interesting and well-reasoned Essay on this subject, by Samuel Bailey, Esq., in his work: "Discourses on Various Subjects."

at this day exists? The hair with which the Lena elephant was covered confirms the accuracy of this conclusion. The mane and long black hair on the rest of the body, according to the principles of this inquiry, could not possibly have been the production of a frigid and cheerless region. They could have originated only in circumstances peculiarly favourable to the development of animal life; such as an abundance of nutritious food, and a genial degree of heat. They are an unerring indication of a state of the vital powers which, from their vigour and affluence, necessitated the growth of the external appendages; and analysed in a justly philosophical spirit, we are enabled to ascend to a knowledge of the conditions by which they were produced.

The phenomena we are contemplating imply not only extraordinary vital activity, far beyond what characterizes the Indian elephant, but a copiousness of food at hand proportionate to the excited demands of animal existence. The mane and the long hair on the body are the expression of a temperate climate;—a climate where large animals wandered, bred, and reposed at ease; subjected to influences which stimulated, nurtured, and evolved structural endowments in their most vigorous and striking form.

The frizzly fur with which the body was also clothed, expresses a much lower degree of temperature, than that which had *originally developed the thick, black hair*. The *former was an after growth in this class of animals*, and was the consequence of atmospheric influences very different from what had previously prevailed. It is evidence of a transition in the constitutional condition of the species, and the *last* which it was capable of bearing.

In a subsequent part of this work, to which we have alluded in the Introduction, we shall enter at length into the consideration of the growth of this kind of fur; and of other similar substances, occurring in animals exposed to cold, as is observed in the change they undergo previous to the commencement of winter. From the importance of the subject, and its connexion with the train of reasoning pursued in regard to the Lena elephant, we shall endeavour to explain in few words, the causes which had developed the singular material alluded to, giving the animal a clothing well adapted to resist the inclemencies of the country it inhabited.

One obvious effect of cold is to diminish the process of transpiration from the surface of the body; and if extreme, it nearly altogether arrests it. To whatever extent this takes place, in the same proportion it lessens the escape of useless matters from the skin, the actions of which continuing, other outlets are created agreeably to the urgency of the occasion. The surplus elements must be thrown off in one form or another. If not expelled in the state of vapour or gas, they will be appropriated to the production of some supplementary appendage. This is a necessity of the cutaneous surface, in relation to the exigencies of the animal system generally; and hence the short and thick fur with which the elephant was amply endowed.

It may naturally be asked: why did it not appear as hair? The formation of this implies great vigour of the powers of life. It is invariably evidence of the fact. The surface of the body is unequal to the development of it, but not of fur, which would have been hair, had constitutional

conditions been adequate to its growth. The presence of it in this animal, and in the swine of the same regions, at the present day, shows with a degree of accuracy amounting to a demonstration, the nature of the atmospheric influences which prevailed at the remote period contemplated.

This species of clothing, in connexion with hair, is never produced except from the agency of severe external cold. The quadrupeds and feathered tribe of our own country, in the winter dress which they assume, offer similar illustrations, and originating in precisely the same causes. As the cutaneous surface loses the power of relieving itself, by the discharge of matters implied in the activity of transpiration, other organic necessities arise, and the effects are observed in the production of a new class of appendages, which fall off with the return of warm and genial weather.

The regions where the Lena elephant was found had gradually become colder, and during the successive changes of temperature, from agreeable warmth to extreme cold, the vegetable creation by equal steps diminished in its luxuriance, until at length there was not a supply to meet the wants of the numerous beings which it once supported. In the ratio of the difficulty of finding food, conjoined with the prejudicial effects of a lowered temperature, they gradually disappeared from the face of the earth. Hence the marvellous masses of bones and tusks where they at one time sported in the enjoyment of existence.

The variety of animals which abounded in these vast, and now cheerless tracts, would be affected in different degrees by the gradual change in the condition of external circumstances. The less vigorous would die off first, and the rest in succes-

sion, according to the character of their constitution. The Lena elephant would probably be among the last. His exterior indicates hardy and robust qualities: they are obvious in the lion-like mane,—in the black hair which clothed the body, and in the abundant fur that in vain warmed him. A period eventually arrived when he could no longer exist.

In reference to the hardiness of this animal, and in support of the line of argument which is here employed, it is important to observe, that so late as 1843, two other elephants were found in Siberia with flesh upon them. From such facts it is clear, that this class of animals was not only common to the country, but must have been among the last that resisted its extreme rigour.

The inhospitable climate which failed to nourish the Lena elephant, nevertheless preserved him,—a rare relic,—a marvel to remote times, carrying the mind back to unrecorded ages.

We will venture humbly to offer a speculation in the endeavour to account for the circumstances in which he was discovered. We have stated that he had outlived a temperature necessary to his existence: in the effort to obtain food he would wander in various directions; nor is it a wild conjecture, that in search of it his footsteps were led upon the ice. If this gave way beneath the pressure of his body, the element into which he was precipitated would freeze around him, and thus he would be encased in the frozen fluid. He was found imbedded in an immense block of ice.

It is scarcely to be doubted, that after the event, the temperature of the region descended still lower; and hence

his perfect preservation and the long dreary wilderness that succeeded. Animal and vegetable life, in huge, rich, and diversified forms, ceased to exist. Withdrawn from atmospheric influences, while empires flourished and decayed;—while nations perished and successive nations rose, he alone remained unchanged:—he looks out from an exceedingly distant period.

Why was he discovered? The question suggests other speculations. The regions have not been stationary in temperature. The causes which produced the one extreme, destructive to animal and vegetable existence, had been gradual and regular in their progress: at a certain epoch changes equally natural would arise, fraught with more genial influences, and to the operation of these *we owe the discovery of the Lena elephant*. Had the same rigour of climate continued which at one time prevailed, the footsteps of man would not have been led to the locality where he was found; nor would the ice in which he was encased have been thawed to have liberated the body. It is on these views only that it is possible satisfactorily to account either for his preservation or discovery: and likewise the existence of animal and vegetable remains, where, probably at the present day, not a type of the individuals they represent exists. The remarks apply to all countries. They all more or less possess objects, which could only have been nurtured and developed by influences in harmony with their requirements;—influences in regard to temperature the opposite to what now prevails.

The views which are here advanced, are in our opinion much strengthened by the recent discovery of the two elephants

alluded to, in a high state of preservation; and also of a rhinoceros, the body of which was covered with hair. From these facts three important conclusions may be drawn. The first is, that numerous animals of this kind inhabited the country where they are found, at an exceedingly remote period; so that the discovery of the Lena elephant, is not to be regarded as evidence of the disturbance of the ordinary laws of nature; or requiring for its explanation any unusual circumstances, which have been employed by writers in the attempt to account for the presence of it in these regions, and the singular endowments by which it is distinguished. The second inference that may be deduced, rests on the abundant hairy clothing of the rhinoceros, showing that at the time it lived, the climate must have been particularly favourable to the development of organic structures. And, lastly, it is also clear, from the long preservation of these animals, that at the period when they perished, great cold had supervened,—an extreme which they were incapable of supporting; and hence the total extinction of them. The circumstances under which the Lena elephant was found, we admit were peculiar; nevertheless, the immersion of it, and the sudden freezing of the fluid into which it was plunged, are explicable on the speculations we have hazarded.

Numerous facts establish the justness of these remarks. It is well known that neither trees nor shrubs are to be traced above 72° latitude. Captain M'Clure, in his late successful attempt to discover a north-west passage, states, "that an exceedingly old Esquimaux encampment was met with in making some inland excursions (apparently in Baring's Island), and a most interesting discovery of a range

of hills, composed of one entire mass of wood in every stage, from a petrification to a log fit for fire-wood; *many large trees were amongst* it, but on endeavouring to exhume them, they were found too much decayed to stand removal;—the largest piece that we were able to bring away being three feet ten inches in girth, and seven feet in length. They were found at an elevation of three hundred feet above the beach, in latitude $74^{\circ} 27'$ north.”

The beds of coal which Captain Parry discovered, both in Melville Island and in Jameson's Land, in Old Greenland, show that forests had existed at a remote period. It is, also, proved that Iceland, which is now a treeless island, had once its birch and oak forests, where the ground is now changed into moors and bogs.

The discovery of the Lena elephant was the consequence of atmospheric changes, which are still progressive towards the establishment of milder and more genial conditions; and we firmly believe that animal and vegetable life is again destined to appear on the stage,—where it is now dwarfed in its proportions,—in the strength and plenitude of nature.

Before leaving this branch of the subject, we must correct certain impressions concerning the state of the Lena elephant when found. Schumachoff, who first saw it, described it “as so fat and well fed that its belly hung below its knees.”

Such loose and general expressions are worthless. When the ice, in which the body was imbedded, gave way, the enormous fleshy mass was precipitated on a sand bank. The concussion, and the position into which it would be thrown, would give an unnatural prominence to the abdomen. Farther: the partial decomposition of the carcase after its

discovery, would render it impossible for the viscera to be retained in their usual situations; and if the body had at all a dependent inclination, the pressure of the contained organs would necessarily occasion a pendulous appearance of the abdomen.

It is indeed much to be regretted, that the animal, previous to its mutilation and removal, was not examined by one capable of furnishing an accurate and scientific description of it. The state of the stomach and intestines, and particularly the nature of their contents, if any, would have cast great light on the circumstances fatal to its existence and that of numerous other animals.

It is stated by Professor Owen,—a high authority on such matters,—that the molar teeth of this elephant possess a larger proportion of dense enamel than those of the living species. The teeth would be modified in structure by the character of the food on which the animal subsisted. Discrepancies of a similar kind are found between the Asiatic and the African species. These, and other differences, are the expression of causes which have acted through a lengthened period on living organic tissues.

We purpose now making a few observations on another animal, viz.: the rhinoceros, which, like the elephant, has its remarkable supplementary appendages; and as we shall attempt to show, the growth of them is due to similar structural and functional conditions. There are two species: in the one, the individuals have two horns; in the other, one. In both cases they shoot out from the snout. These singular structures are nearly as thick as the tusks of the elephant, and are sometimes three feet or more in length.

The animal lives on vegetable food, and may be described as quiet and inoffensive in disposition. Were it not for these horns the head would have the character of that of the hog,—a form which indicates a large development of the external organs of smell, taste, and touch, and equally of those of mastication.

The structure which is peculiarly interesting to study in this animal, is the upper lip. In its vital and physical properties it has a striking analogy to the proboscis of the elephant. It is not, like the latter, a flexible tube, but it is scarcely a less dexterous or useful instrument for the purposes of existence. It is capable of being so elongated as to reach and draw down branches of trees. Its muscular and sensitive powers, and the manner in which they are exercised, establish, as in the case of the proboscis, extensive vital operations in the tissues from which the tactile organ springs. They will be a centre of extraordinary activity, and in the same degree will an urgency arise for the escape of surplus elements. The only mode in which they can be emitted, is in the form of some particular appendage; and, in the present instance, it is in the condition of horns; not on the upper part of the head, as in ruminants, but shooting from the snout of the animal. Why from this particular region? It is here only, reasoning physiologically, that the horns could grow. They are not a fortuitous production;—organs bestowed for ornament or for the diversity of animal expression. In agricultural language, they grow where the soil not only conduces to, but necessitates the development of them. The vital actions of the snout and its contiguous tissues must have an outlet for the

matters which have to be expelled, and we trace them in the form of horns where alone they are required.

Numerous bones of the rhinoceros have been found in Siberia, Germany, and other parts of Europe. An entire animal of the fossil species, differing greatly from any at present existing, retaining its skin, fat, and muscles, was dug up near the Vilhovi, on the east of Siberia, in a situation which even *now* is covered with ice the greater part of the year. The animal was *likewise clothed with tolerably thick hair*. The latter fact is peculiarly valuable in connexion with these investigations, being evidence, as in the case of the Lena elephant, of constitutional vigour far greater than is possessed by the living races. This structural appendage has altogether disappeared from them. Hence it is clear that its presence or absence is simply the expression of the prevailing state of the vital powers. A necessity in one case exists for the growth of hair,—a necessity in relation to internal functions which fails to show itself in another. If the influences of climate, within extremely moderate limits, are capable of producing what is now an unusual species of clothing, is it not reasonable to conclude, if extreme in degree, and operating through vast spaces of time, that far greater changes will be the consequence? Will not the animal, in its configuration and structure, conform to imperative external conditions? To what extent it is impossible to state. This, however, we may fearlessly assert, that whatever alteration is induced in any class of *essential* organs, will affect in a corresponding degree the entire animal system.

There are several varieties of the living rhinoceros more

or less differing from each other; as the Indian, the Javanese, the Sumatran, the Cape, and the Ketloa recently discovered. The last has horns of equal length, and is remarkable for its ferocity. All these have the singular development of the upper lip susceptible of considerable elongation, with a single exception. It is stated that in one of three alleged African species, the lip is incapable of being drawn out as in the rest. How far this may affect it as a centre of activity we are not prepared to say; nor are we informed, which is extremely important, what difference there may be, if any, in the development of the horns in this animal.

In the hog tribe we have a conformation of the snout indicating a large expansion of the organs of smell, touch, and taste; and in the wild boar, displaying the effects of these in a state of nature, the tusks are of great size. They have been observed almost a foot in length. In domesticated swine they are of small dimensions, and from obvious causes. The habits and circumstances of the animal are widely different. It is fed, and has not to seek its food; consequently the organs alluded to *are in their lowest state of activity*. They are not stimulated in a way to constitute them a centre of vigorous vital functions. The smallness of the tusks is evidence of the fact: and further, the confinement of the animal and the food on which it subsists greatly reduce the tone and energy of the constitution;—a result which is expressed in the copious secretion of fat. The blood and nervous power implied by these conditions could not possibly throw out large tusks.

The character of these in the wild boar materially

strengthens the physiological principles laid down. It would be difficult to find another fact more strikingly apposite in support of them. The animal has to use no ordinary efforts to obtain food;—efforts which compel it to plough up the ground in search of it, in the process of which the organs of smell, touch, and immediately afterwards, that of taste, are aroused to the highest pitch of activity. What does this necessitate, but the disengagement of elements from the excited tissues in the ratio of the local actions existing? and they can escape only in one form, *and that is in the development of tusks.*

In further illustration of the views brought forward, we shall allude to another animal, viz.: the hippopotamus. This huge and unsightly creature has neither a proboscis nor any analogous organ; consequently is destitute of special and prominent external appendages. Had they been present, unconnected with the organic conditions defined, they would have furnished an insuperable objection to the principles characterizing these researches. The animal creation offers no such exceptional case.

It is not our intention, nor is it needful to adduce further instances in corroboration of the views advocated: these have been discussed at considerable length, and the application of them to a wider range of objects cannot be a matter of difficulty.

Before concluding this branch of the inquiry, we shall briefly recapitulate the substance and bearing of the preceding observations.

In general terms, the appendages which have been brought under notice, have no obvious use: the greater

part of mankind instinctively feeling that everything has been given for a definite purpose, and this one of utility, naturally exercise their ingenuity in the attempt to discover what it is. In regard to some of these organs, the mind satisfies itself that they were bestowed for ornament : with respect to others, it perceives an end in the adaptation of them to the gratification of combative propensities : in reference to a third kind, equally supplementary, it can detect only a glimmering of use, but too shadowy to induce the belief that this was the end contemplated in the development of them ; and lastly, in others it can trace no intelligible manifestation of design.

Utility, as generally explained, can scarcely be the purpose for which these objects were created. They appear and disappear in the same species of animal, according to the influence exercised by external circumstances. Their presence or absence does not in any degree affect the functions of life. It may be evidence of conditions implying greater or less vital vigour ; but in this view they are supplementary and not *essential* organs. We have endeavoured to show, that they are subservient to important ends in the animal economy ;—furnishing outlets for elements that could not be disposed of in any other way. The appropriation of them in these various structural forms, tends to preserve and secure the well-being of more vital organs ; and at the same time the parts from which these matters are expelled,—in the actions of which they are the seat,—are to be regarded in the light of safety-valves in relation to the body at large. It is in these points of view that the utility of the appendages receives its just interpretation.

Is it rational to conceive that the horns of domesticated ruminants were given as an ornament, or to enable them to injure each other with greater facility? It is true that they are used in combative encounters. But when they are wanting the animals butt with their heads; and, in our opinion, there is quite as much evidence of utility displayed in the one case as the other.

In conclusion, these supplementary structures owe their existence to organic necessities. They grow only where these exist; and as the constitutional requirements become less imperative, from diminished bodily vigour,—which may be induced by a variety of causes, the *unessential* organs altogether disappear or are very imperfectly developed.

CHAPTER XII.

THE INFLUENCE OF THE GENERATIVE SYSTEM ON THE DEVELOPMENT OF APPENDAGES IN THE LOWER ANIMALS.

IN treating of the growth of hair and of other structures, in man, and in animals generally, reference has repeatedly been made to the influence of the organs of generation in the production of them. The fact was too obvious not to attract attention, and numerous examples have been given in illustration of it. The importance of the subject merits further remarks. In investigating the causes which determine the development of horns in ruminants, we endeavoured to point out the organic conditions, which accounted for the persistence of the external appendages in so large a proportion of them, and the annual shedding of them in others. On the present occasion, it is our intention to enter at greater length into the inquiry. The constitutional circumstances which establish the distinction, have a peculiar value in relation to the physiological principles brought forward.

The beings composing the vast chain of animated nature, though differing greatly in structural and functional endowments, have, nevertheless, many points of resemblance, if

not in regard to form, in the uses to which certain organs are subservient, and especially in the mode in which the propagation of the races is accomplished.

As we ascend in the scale of creation, the means for accurate and comprehensive comparison are immensely multiplied, and a great variety of analogies forces itself on our notice. When we reach the links nearest to, or at no great distance from, man, we discover organs and functions only slightly removed from those by which he is distinguished; and, as a necessary consequence, a similar class of appendages.

In the analysis of the organization of the human species, tracing the causes of the differences in form and external conditions between the two sexes, we found that they were to be ascribed to the influence of the generative system;—in the one, drawing the currents of life from without, inwards; and in the other transmitting them from within, outwards. The same causes, and the analogous effects to which they give rise, present themselves with more or less distinctness throughout the animal kingdom.

In certain fishes, the colours of the male are much more brilliant than those of the female, as in the *Cyprinus tinca*, and in the *Syngnathus papacinus*. In the *Labrus viridis*, the male is of a bright, and the female of a dark green: and in the *Lutjanus melops*, the former is red and the latter brownish. In the *Cottus scorpius*, the belly of the male is red, and that of the female white. Similar differences are found in the *Cottus anostomus*, and in the *Gasterosteus pungitius*. Many other examples might be given. In these instances, we perceive the influence of the male

generative system on the functions of life. It is shown in a greater brilliancy of colours,—evidence of more vigorous vital conditions, establishing on the surface of the body far greater vital activity than is possessed by the female. Wherever increased currents of blood and nervous power are conveyed, comparing these in the two sexes, we have invariably corresponding structural results, either in the presence of supplementary appendages, or in greater splendour or variety of tints. The female, among the lower animals, has generally fewer of those external endowments which fascinate and attract by their beauty or the diversity of their expression. This is strikingly the case in the winged part of the creation. On many of them nature appears to have exhausted her resources in the production of rare forms, singular appendages, and magnificent colours; and, with few exceptions, they are the characteristics of the male. We shall adduce a few examples.

In most of the instances, in which the supplementary structures of the male are peculiarly beautiful, *they are only temporary distinctions. They disappear after the season of love, and return with its awakening power*: such is the imperious influence of the masculine organs of generation.

Nature here, though fitful in her manifestations, economises her powers. The season that excites the amative propensity, arousing in both sexes of the feathered tribe feelings implanted for special ends, directs the vital currents in opposite directions. In the one, life is concentrated largely within, fitting the internal organs for impregnation and consequent functional changes: in the other, the stimuli are thrown in extraordinary copiousness on the sur-

face of the body; and, as an inevitable effect, are, in many cases, expended in the creation of remarkable supplementary structures, exquisite for their rare and dazzling colours.

The humming-birds, and the birds generally of tropical regions, furnish numerous illustrations of the truth of these observations. Among the former, we have the *Trochilus Delalandii*, adorned with a beautiful crest, the fore-part of the throat, breast, and belly, displaying a rich azure blue. The female is wanting the crest, and in other respects has a much more sober appearance. The male and female *Trochilus magnificus* present differences no less striking in their colours and in the character of the external appendages. In the next example, *Trochilus cornutus*, words can only very imperfectly describe the adornments of the male. It has its two flattened crests, formed of six feathers, which divide in front of the head, and the brilliancy of their hues is equalled by few, and surpassed by none, of the feathered race. The female does not possess the crests. The male *Trochilus vesper* has the rich gorget of which the female is destitute.

In these, and others of the same family, in which similar discrepancies may be traced between the male and female, the characteristic structures of the former are the nuptial dress, and disappear after the occasion to which they owe their development.

In the *Nectariniadæ*, or Sun-birds, we have similar examples of the influence of the generative system in the production of temporary adornments, and of magnificent colours. The male *Nectarinia chalybeia* has the head, back, rump, throat, and upper part of the breast, of a golden green, varying in different lights; and succeeding the

green of the breast, there is a band of rich steel blue, and then a crimson band of nearly double the breadth. The colour of the plumage in the female is a brocoli-brown. The differences are equally great between the male and female *Nectarinia afra*. The male *Nectarinia splendida*, is the most gorgeously adorned of the whole tribe, and hence the epithet applied to it. The female is of an earthy brown colour. Similar differences exist between the male and female *Nectarinia senegalensis*, the *Nectarinia amethystina*, and the *Nectarinia violacea*. The last of this family we shall mention, is the *Nectarinia fumosa*. The long tail feathers, and the brilliant tints of the plumage, impart to the male a gorgeous appearance. The female is of an olive-brown colour.

In this class of birds, as in those previously alluded to, the singularly beautiful appendages and colours of the male are the production of the season of love. They disappear with its cessation. They illustrate in no ordinary degree the influence of the organs of generation.

Many of the males of our own native birds present facts scarcely less striking, than those which have been brought under notice, originating, also, in the sexual passion. The brown tips to the feathers on the crown of the chaffinch are changed to a rich blue; the breast of the linnet assumes a lovely crimson tint; the heron and lapwing acquire their crests; the black-headed gull gains its soft and chaste-looking cowl; the teal, wild drake, and goosander display their glossy heads, and the grebes their auricular feathers.

The several varieties of the pheasant tribe offer differences not less remarkable, in the appendages and colours charac-

teristic of the two sexes. The *argus* pheasant, superbly adorned, is furnished with a long and splendid tail; and in this respect, and in the exquisite richness of its plumage, it forms an extraordinary contrast to the female. The *golden* male pheasant, from its temporary structures, clothing, and the magnificence of its colours, is the most gaudy of the race. The female has the usual unobtrusive brownish plumage. There are differences with which most are familiar, between the male and female pheasant of our own country at the breeding season in particular.

The supplementary appendages of the two sexes are very unlike in domestic fowls. The cock has the large erect comb, while that of the hen is small and pendent. In the capon it is only slightly developed. In the Turkey cock it is of considerable size, and swells with the excited emotions of the animal. A similar organ, varying in its position, is common to the males of other species. Sometimes it is on the head, occasionally on the beak, and in the *phoca cristata* it is on the nose, and is pendulous on each side of the mouth. The male turkey, and peacock, have particular feathers in the tail, brilliant and diversified in colours, which are capable of being so moved as to assume the form of a fan. Passing from these to quadrupeds, we find that the he-goat has a much longer beard than the female. The male wild goat only has this appendage. Among the several ruminants, possessing horns on the head, as the elk, the gazelle, and certain varieties of deer, they are observed only in the male: and where they are common to both sexes, as in the rein-deer, the goat, and the chamois, there is an obvious difference in the character of them.

The various structures and external vital conditions which are here brought under consideration, are to be studied in connexion with the powers of life generally, and in the same points of view as the beard in man. Horn, hair, and feathers differ little in constitution. They are similarly implanted in nervous and vascular tissues, and are the result of extraordinary vital activity in certain regions, displaying in their manifestations, the influence of the generative system ; and, moreover, are outlets for surplus elements thrown off in supplementary organs agreeably to the scheme of organization peculiar to the animal.

The facts which are here recorded scarcely admit of doubt. Nature, in the numerous instances brought under observation, speaks too openly,—in a way too direct and plain to be misunderstood.

It may be remarked, what will be obvious on its enunciation, that as the sexual passion does not possess the same force in all animals ; or, in other words, does not awaken the same disturbing influences throughout the nervous system, an equal necessity will not exist for the growth of special appendages distinctive of the male sex, in the different orders of beings. These have their temperaments, as well as man, or conditions which express vital actions, varying greatly in degree, and to the same extent modifying the demands for external structural creations.

In a previous part of this inquiry we have alluded to the red-deer, as furnishing a striking example of the agency of the generative system on the animal economy. The important physiological facts with which it is accompanied merit a further investigation.

The phenomena which the male exhibits, and the views on which they are explicable, have a direct application to a large class of animals.

The season of excitement lasts about a month, after which the stags, emaciated and dejected, become quiet and peaceable with each other. They again feed in common, requiring rest and food for the restoration of their strength.

The altered state of the body which is induced,—extreme weakness and loss of flesh, is incompatible with the continuance of the antlers. The parts from which they immediately derive their nourishment, are no longer centres of *excited* nervous and vascular actions. The previous external relations with the internal organs cannot be maintained. The enfeebled constitution is equal only to the pressing requirements of mere existence. Life, greatly diminished in its resources, is concentrated within for the future building up of the body. The withdrawal of vital power from the head, and from the cutaneous regions generally, gradually takes place, and in about four months the antlers are shed.

We shall now endeavour to trace what follows. The animal by slow degrees progresses in condition, and in the same ratio the generative organs are developed, and begin to exercise their natural influence on the system at large. They impart a fresh and invigorating stimulus, which arousing nervous matter, quickens and strengthens the movements of the heart; in consequence of which a fuller and more vital stream of blood is put in circulation, flowing abundantly from within, outwards, until at length organic necessities are created, and the urgency of them is observed in the production of antlers. Will it be doubted

that the gradual formation of them, offers an immense outlet for the escape of elements from a particular region of the body, the situation and nature of which are determined by the process of *rumination*? During the growth of the appendages, the animal system is acquiring vigour and vital energy to fit it for ulterior purposes.

The first appearance of the horns is no evidence that the required structural and vital conditions are attained; no more than the first hairs on the chin of a youth, at puberty, prove the matured development of the body or of the generative organs. They both simply indicate an induced and important change in the powers of life; and in both cases it goes on, in the one, until the completion of manhood; and in the other, until the vital energies can no longer find an issue adequate to their demands in the production of magnificent horns. What are the phenomena which at this time present themselves? The season of excitement returns. The animal is again maddened and furious from the irresistible influence of passion. The imperious necessities of nature are relieved, and the same round of changes, decay and resuscitation, follow. The completion of the antlers is the suspension of an external outlet; and it is at this stage that the powers of life, vigorous in the affluence of their energies, rouse the generative system, and adapt it to the accomplishment of its objects.

It is clear, that during the development of the supplementary structures, the chemical elements resulting from excited vital operations, have an escape in the formation of them; but coincident with this appropriation, it must be kept in mind, that every part of the animal system is likewise pro-

gressing,—exercising a wider range of functions, and in an especial degree the generative apparatus. When the antlers have attained their full growth, the expenditure of useless matters is interrupted; nevertheless these continuing to be largely produced by the vigorous actions of the body, and having no issue in the creation of particular appendages, an additional stimulus is conferred upon the generative organs, and hence the furious and maddening effects described.

In the rein-deer, as previously observed, the male and female have equally horns; in the latter, however, they are smaller and less branching. They are not shed at the same period in the two sexes, and the difference, in this respect, suggests physiological considerations of deep interest, corroborating in a remarkable manner the principles we have laboured to establish.

In the male, the antlers are shed after the rutting time, at the latter end of November. The cause of their falling off, as already explained, is the inability of the vital powers to support them. The fact is evident in the emaciation of the body. In the female they are retained until she brings forth. The gradual growth of the foetus is an invigorating process, and particularly in animals in a wild or comparatively wild state. Vital resources are abundantly created, and the liberal distribution of them accounts for the continuance of the antlers beyond the period which is common to the male. On the termination of the foetal process, obvious and important changes take place in the animal system. Milk has now to be formed for the nourishment of the young, and the organs engaged in the production of it are

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new centres of vital action, furnishing an ample issue for surplus elements, that would otherwise be transmitted to all parts of the body. The withdrawal of them from the cutaneous and other regions, is the occasion of constitutional modifications incompatible with the persistence of the antlers: the circulating fluid and nervous power fail to be conveyed, as before, to the structures in which they originate; and therefore, as a necessary consequence the shedding of them.

The temporary appendages of other animals peculiar to the season of excitement, admit of the same explanation, both as to the causes of their growth, and the shedding or moulting of them. The perfection of them, at one period, thrown out in all their luxuriance, shows that the animal system has reached its external limits;—cannot further expend its powers in the growth of supplementary structures. These, on their completion, making no demands beyond what is essential to their nourishment, superfluous materials exist and have to be disposed of in some mode. It is now that the sexual organs enter upon their active functions. Life is, in some degree, roused from *without*, *inwards*, from the vigour and restless movements of the body; and the gratification of the sensual appetite, is the new outlet established in harmony with the requirements of the constitution.

When the stag is emasculated while young or after it has shed its antlers, they are not again produced. Shapeless tubercles occupy their place. Capons, from the same cause, have small combs and gills, and differ little in appearance from pullets. They in no way display the pride

and majesty of the cock, but cover chickens like hens. Wethers and oxen are similarly changed in character. They approximate in several respects to the female. We shall not multiply instances of this kind. A uniformity of results follows the mutilation of the organs of generation.

It is stated by Valmont de Bomare, that in a hind which had horns,—an unusual production, he found the ovaries greatly enlarged; in fact in size like the testicles, and at the same time the clitoris was of inordinate dimensions. In this interesting case, as in one previously alluded to, we observe that extraordinary constitutional changes are induced on the establishment of a morbid centre of activity. The same writer further remarks: that roes will occasionally assume horns, if well nourished,—kept closely confined, and at the season of excitement not allowed to have intercourse with the male.

The food and confinement, conjoined with the aroused sexual passion, produce a plethoric state of the system. The blood abundant and rich in stimulating properties, and having no issue in connexion with the organs of generation, is expended in the creation of appendages characteristic of the male. It is in this manner only that the exigencies of the body can be relieved.

Cases of this description are exceedingly curious, and have a value which it is scarcely possible to overrate in connexion with the views brought forward. They show that the female, under particular conditions, may display the characteristics of the male, in respect of supplementary structures, either from disease of the generative organs, or from an extremely vigorous state of the body induced by an

abundance of nutritious food, conjoined with confinement;—circumstances which excite and aggravate the natural violence of the sexual passion.

In the second part of this inquiry, which is alluded to in the Introduction, many of the matters discussed in the previous pages, will, under other forms, or in connexion with a different class of physiological considerations, be again brought under notice.

CHAPTER XIII.

THE ANALOGY BETWEEN THE PRODUCTION AND USES OF FAT
AND OF HAIR IN THE HUMAN SPECIES.

THE train of reasoning pursued throughout this work naturally suggests the present subject. In discussing the supplementary appendages of the animal body, we have laboured to establish this important fact, that their office consists in affording an issue for elements rendered superfluous by constitutional and local actions.

Among the matters which have to be expelled, and forming the greater part of them, is carbon, which enters very largely into the articles of food on which man subsists, and a considerable amount finds an exit in the exercise of pulmonary respiration. The capacity of the outlet in this direction, is in the ratio of the consumption of oxygen with which it comes in contact. The surface of the body is another channel through which it is emitted. The kidneys and intestines are likewise, to some extent, instrumental in the expulsion of it. It is, however, principally through the respiratory process that carbon is conveyed out of the system. The quantity thrown off in twenty-four hours, in man,

exceeds what would be imagined possible, were not the fact placed beyond doubt by direct experiment. Great as the amount is which escapes through the various channels alluded to, nevertheless it frequently exists in excess, and to a degree incompatible with a high state of health. When such is the case, independently of the presence of disease, *the usual result is the production of fat.*

It is a law of the animal economy that every organ should possess, in some form, what may be designated appendages; or indeed an annexed tissue the development of which is a relief to more vital structures, and a protection against their frequent derangement. The actions which have an immediate relation to the surface of the body, have, as we have shown, their supplementary organs. The vital processes carried on within the body, have equally theirs, and consist in the development of the adipose tissue.

The considerations which have led to the adoption of this opinion rest on facts which are worthy of patient study.

Every organ is a centre of vital operations, implying the reception of arterial blood and its conversion into venous. Of the mode in which this takes place we have no positive knowledge. In ordinary language, it is stated that the former, losing its oxygen, acquires the properties of the latter: and further, carbon, and other elements resulting from the waste of the body, are added to the venous current.

Wherever the change occurs in the transformation of arterial into venous blood, matters will have to be thrown off from the *surface* of the different internal organs, as a necessary effect of the activity of which they are the seat.

We may advance a step further in the inquiry. The elements emitted will be in the ratio of the impurity of the blood, or the predominance of carbon in its constitution.

No two organs, except those performing the same office, possess the same structural and functional conditions, and the differences by which they are distinguished will show, that they do not equally require the aid of the adipose tissue, as an appendage by which they may, under particular circumstances, be relieved of useless substances. We shall endeavour to furnish illustrations of the fact. The lungs exercise extremely active functions, and afford an immediate and ample outlet for the carbon of the venous blood conveyed to them. The essence of their action is the reception of oxygen and the *expulsion* of carbon. How plethoric soever may be the constitutional tendency, the adipose tissue is never developed in the respiratory organs.

We are sensible that this will be regarded as a wise provision, which we freely acknowledge, as the presence of fat, and the liability to its accumulation, would impede the action of the lungs and seriously disturb the functions of life generally. While we are, we trust, keenly alive to, and may contemplate with admiration the provision in question, we must not allow the feeling to withdraw us from the study of the laws by which it is secured. Man was intended to investigate the works of creation, and the more deeply he pursues his researches, the more elevating are the traces of design brought to light.

If the provision be wise with respect to the lungs, we must remember that the secretion of fat, in connexion with other important organs, frequently interferes with their action and

produces extremely prejudicial results. We make this remark, in order to show that the wisdom manifested in the conditions of one organ, is not equally apparent in reference to others, confining the observation strictly to the point in question.

The exquisite perfection of animal organization,—the nice adaptation of means to ends, and the harmony pervading the living machine, can be discovered and appreciated only by profound physiological investigations. The existence of fat, in situations interrupting the movements of organs, and to this extent a cause of disease, and occasionally of death, is, nevertheless, a provision which nature has given to counteract or lessen the liability to such evils.

The heart, in its structural conditions, is intermediate between the lungs, and other organs to which we shall subsequently allude. It is ordinarily destitute of fat, but in some cases it is loaded with it. We shall first study the circumstances which account for the absence of this substance.

The phenomenon is explicable on the functions exercised by the heart. This is a vital centre, but in its nature unlike that of every other organ, save the blood-vessels with which it is connected. *In one point of view, it is not, however, a centre of extraordinary activity*, as the lungs, the kidneys, and the intestines. It is not, with one reservation, the seat of processes by which the blood loses and acquires particular elements;—by which fluids are secreted from it, or by which nutritive materials are variously affected and prepared for the support of the body. It is simply a centre of propulsive power, giving rise to no alteration whatever in the properties of the blood; and, therefore, it has not

the conditions necessary to constitute it an organ characterized by extensive vital changes. The functions which it performs do not occasion the emission of useless elements, and, consequently, as a rule, it is devoid of fat.

The argument is here stated generally, and with one reservation only. The heart, in common with every other tissue, has its arteries and veins, and the contents of the former are converted into those of the latter, and in the ratio of these particular actions waste elements have to be expelled from the organ.

The origin of fat is what may be termed an open question among physiologists. By some it is ascribed to the action of the vessels where it is deposited; by others, it is imagined to exist already formed in the blood. Bécлар failed to detect it in a free state in the circulating fluid. He admits that M. Chevreul discovered a fatty matter in solution. Two recent authorities * speak unhesitatingly of the existence of it in the blood, both in a crystallizable and oily form, and in the proportion of four parts in a thousand.

The principles which it is our object to establish, in reference to the production and distribution of fat, will not in any degree be affected by the views entertained concerning its origin.

On this occasion we shall treat of it as it appears in the human species. It is found in the orbits, the cheeks, the palms of the hands and the soles of the feet; likewise around the kidneys,—in the mesentery and omentum, in the *appendices epiploicae*, on the heart, in the areolar tissue of the abdomen, in the mammæ, in the cancelli and canals

* Messrs Todd and Bowman, *opus cit.* p. 85.

of the bones. It is also discovered in the liver, the brain and nerves ; but in these situations it is not enclosed in vesicles.

In the discussion of the subject we shall select a few of the most important of these regions for examination.

The circumstances which give rise to the deposition of fat are general and local : *the former, is the condition of the blood ;—the latter, the action of the blood-vessels in particular localities.*

The heart, as previously stated, is destitute of fat, or only slight traces of it are detected in persons who are lean ; while in those who are exceedingly corpulent, it forms thick layers on the apex, and especially on the base of the organ. The accumulation is at times so abundant, that from disturbing the movements of the heart it is occasionally the cause of death. Why is it deposited in this situation ? What end does it serve ? The answer we shall give will apply to the production of fat in every other region of the body.

In persons remarkable for obesity we have two obvious and indisputable facts to analyse. It is clear that the supply of food to the animal system has been greater, in a given period, than the expenditure of the vital powers. A larger amount, in fact, has been received than has been thrown off from the lungs,—the skin and other channels. This state of the body is not always to be ascribed to the free indulgence of the appetite. It occurs particularly in females after the prime of life, many of whom certainly cannot be charged with excesses of this kind. A difference in the circumstances by which it may be produced will not at all affect the views which we purpose to unfold.

The fact of the body receiving more from without than it is capable of expelling in surplus matters, suggests an interesting inquiry in reference to the properties of the blood, the consideration of which will first occupy our attention.

The food of man is rich in carbon, and there is only one great outlet through which the latter can be thrown off in the proportion of its admission, viz.: the respiratory process; and unless oxygen be inspired in a corresponding degree, one common and inevitable effect, is *the deposition of fat*. Indulgence in nourishing articles of diet is not necessary to its production. Inactivity of body, which is often accompanied with that of the mind, is a fruitful source of obesity in both sexes. To occasion a copious secretion of fat, it is only needful to disturb the balance, which is preserved in the highest state of health, between the oxygen and carbon received into the system through two different channels. When the functions of life are scarcely at all excited by active and invigorating occupations, respiration is proportionately circumscribed. The inspirations may be perfectly regular, but they are less in capacity, as well as in number, than would co-exist with a moderate amount of bodily exertion. In the short space of twenty-four hours, the difference would be considerable in the quantity of oxygen inhaled, between a person whose habits are indolent, and one engaged in bustling and interesting pursuits,—which do not simply imply muscular activity, but the expression of the feelings in lively and social intercourse;—circumstances which powerfully call into play the respiratory organs in various ways. Animated conversation carries into the lungs a large supply of oxygen, that would not otherwise have

reached them. It seizes the carbon and comes out with it, and to this extent purifies the blood.

In females, having little to do, and doing that little in a manner that scarcely exercises a single important muscle,—certainly not according to the intentions of nature,—we have numerous examples of the deposition of fat. How does this arise? Food continuing to be received and digested, though imperfectly, the blood, at length, acquires an undue proportion of carbon, the oxygen inspired being inadequate to combine with it in the lungs in a degree essential to vigorous health. Hence the circulating current has carbon in excess.

This state of the blood, according to the extent in which it prevails, indicates a low state of the vital powers. We have not those conditions which throw the energies of life from within, outwards, creating in its affluence muscular fibre, and in man a luxuriancy of beard.

The circulating fluid not being able to dispose of its carbon, in a way conducive to the well-being of the animal system, may be said to labour in the effort to relieve itself of an oppressive burden; and the only mode in which this can be accomplished is by the secretion of fat, which accurately expresses the necessities of the body. The blood makes it, because it is unequal to make anything better. The production of it, beyond what contributes to the beauty or graceful proportions of the human form, is a species of disease. It is evidence of a disturbed balance between what is received by and emitted from the system.

After these remarks, we are prepared to inquire in what way the more vital organs are protected by the growth of fat, from the liability to injurious effects. We shall find

that the end is attained by the development of appendages,—understanding by these the creation of a particular tissue, viz.: the adipose;—appendages which are not only a relief to important structures, but like those of which we have previously treated, indicate with unerring precision the nature of existing constitutional conditions.

We shall resume the consideration of the heart, as this will furnish a striking illustration of the principles advocated. Blood surcharged with carbon, and, therefore, deficient in vital qualities, is conveyed to the substance of this organ, —to the vessels engaged in *nourishing* it. From the superabundance of its carbonaceous elements it is ill adapted to the requirements of muscular fibre. It possesses in excess what this does not want, and what would speedily destroy life, by impeding or arresting the movements of the organ, were it retained within its muscular structure.

Every organ, whether internal or external, exhales or throws off matters of some kind from its outer surface. It is an inevitable result of vital action. The blood-vessels of the heart struggle to relieve themselves of surplus carbonaceous elements. They can effect this only in one way:—by increasing their operations in the direction of the external surface of the organ. They work after this plan;—*and hence the secretion of the adipose tissue*. This had previously no existence; and, therefore, it may properly be called an appendage, and in the sense in which this term is employed with respect to other organic structures.

The development of this tissue is occasioned by the extension of blood-vessels from the surface of the heart. In their necessities they shoot beyond it, and the result is

the deposition of fat. If the morbid requirements of the heart increase in urgency, the same vessels are further elongated, until at last an amount of fat is deposited on the organ interfering with its free and easy motions.

New vessels never shoot out from an organ, except from increased vital actions in the direction of the region from which they arise. It is, therefore, evident that those of the heart, embarrassed with imperfectly oxygenated blood, have their operations augmented towards the surface of the organ, and the consequence is the secretion of fat. The presence of this, under existing constitutional conditions, has its utility. Had not the vessels of the heart the power, and the opportunity of throwing off the morbid qualities of the blood in the formation of this supplementary tissue, death would quickly ensue.

This provision is evidence of design; or at all events it must be acknowledged, that the manner in which it shows itself, affords a protection to important organs against the prejudicial influence of a state of the blood, that may with strict propriety be designated diseased.

Another class of organs, viz. : the kidneys, are well calculated to exemplify the same physiological principles. The structural and functional contrasts between them and the heart will be found to strengthen the train of reasoning pursued.

In treating of the heart, it was stated, that it is an extremely limited vital centre, restricting the term to the nature and extent of the operations carried on *within* its structure, indicating the degree in which the arterial current is converted into venous blood, which may be taken as a measure of the vital actions of an organ.

The office of the kidneys is to secrete, so that the arterial fluid sent to them is not merely for the purpose of maintaining the renal tissue in health, or fitting it for the performance of a given function, as the blood circulating in the vessels of the heart: it is transmitted to them, in order that it may yield up a variety of elements the aggregate of which constitutes the urine.

It would, therefore, be expected that the amount of blood conveyed to the kidneys would be greater, in the ratio of the differences, as explained, in regard to the functions of the two classes of organs. It follows from the line of argument which is here employed, that when the animal system is suffering from blood in too carbonized a state,—necessitating the production of fat, the kidneys will display it in far greater abundance than the heart. Such is indeed the fact, and is observed to a remarkable extent in the various animals slaughtered for domestic purposes. We are not aware of an exception. In the human subject it is, also, occasionally found in considerable quantity. In oxen and sheep the kidneys are literally embedded in fat.

The blood is conveyed to these organs for the secretion of urine, but from the unhealthy character of it the end is imperfectly accomplished. The chemical matters in which it abounds have to be disposed of to enable the kidneys to continue their secretory functions, and the way in which this is effected, is by expelling them in the direction of the surface of the organs, and in this situation they appear in masses of fat. The degree in which this is thrown out is evidence of the difficulties against which the animal system has to contend, from a predominance of carbon in the blood.

The fattening of cattle may be defined in few words. It consists in destroying the normal balance between the oxygen and carbon in the lungs. The object is attained by nutritious diet, and the comparative quiet or repose of the animal. The former introduces into the body a large amount of carbon ; and the latter diminishes the oxygen that would otherwise have been received ; hence the artificial condition of the system induced displaying a redundancy of the adipose tissue.

The admission of oxygen in respiration, is not only interfered with by stall feeding, which is bodily inactivity, but by a cause that affects equally the human and the brute species. As an animal acquires fat, which is deposited on internal and external structural regions, the natural capacity of the chest is lessened by the enlargement of the contents and parietes of the abdomen : this from being expanded in all directions, the pressure upwards leaves less space for the play of the lungs, and in consequence the blood which they receive is imperfectly acted upon by the inspired air. To whatever extent this circumstance operates, and it is clearly a cause capable of exercising considerable influence, it will diminish the reception of oxygen and the escape of carbon : it will certainly not allow the former to produce those changes in the blood essential to a vigorous state of health ; but, on the contrary, create a disposition to the growth of the adipose tissue.

Other causes might be mentioned tending to aggravate the impurity of the circulating fluid. The accumulation of fat around the heart will interfere with the regularity of its movements, and of course with the distribution of the

blood ;—conditions prejudicial to its thorough chemical changes in the lungs.

We shall now enter upon the examination of the stomach and intestines, the study of which, in connexion with particular appendages, will bring under notice, in an exquisite form, the provisions which nature employs to protect the more vital structures from serious disturbance, that would be liable to occur from the frequent derangement of the functions of life. We shall discover, that while she acts according to a general scheme in the attainment of important ends, she modifies the means agreeably to the special requirements of the viscera. In treating of the heart and kidneys, it was stated, that the fat which the vitiated blood secretes is thrown out upon the surfaces of these organs, as it does not in these situations, except when the quantity is great, interfere with their operations. In these instances nature adopts a ready mode of getting rid of an evil.

The stomach and intestines have very different structural conditions. The one is a capacious cavity, and the other are large tubes of variable dimensions. The parietes of both are formed of several thin membranes, endowed with properties enabling them to contract, and in such a manner as to influence the position and progress of their respective contents.

Were fat to be deposited on these organs they would be incapacitated for the performance of their functions. They would become inert and useless. It is, therefore, not developed in these situations. Another plan is followed to secure them from injury when the blood necessitates the

abundant growth of the adipose tissue. To protect them against an evil of this kind, they have remarkable structural relations to the Omentum and Mesentery;—membranes which lie over, and are variously connected with them; the use of which has hitherto been supposed to consist in lubricating the surfaces with which they are in contact;—filling up inequalities arising from the rounded form of the viscera, and giving mobility to the intestines. They are further regarded as preventing the escape of heat from the viscera,—a view strongly urged by Cuvier. We shall endeavour to prove that they have a utility which has not been suspected, and which is on many occasions essential to the continuance of life.

The anatomical part of the subject, necessary to a just appreciation of the principles advanced, can only here be touched upon generally.

The Omentum receives different names according to the viscera with which it is in particular relation. The consideration of its divisions does not concern the broad outline of this inquiry. It is sufficient to know that it is a reflection of the peritoneum, *and is a medium for the transmission of blood-vessels to the intestines*,—a fact which it is important to keep in mind.

The Mesentery, which is, also, a production of the peritoneum, is formed of membranes, glands, arteries, veins, nerves and fat, and is extremely rich in blood-vessels. The arteries which it receives, the subsequent divisions of which are numerous, are expended upon the large and small intestines, so that the blood, when it reaches the latter, has previously passed through some portion of the Omenta and

Mesentery,—the *supplementary organs of the viscera*. This mode of transmission allows the blood, when charged with carbonaceous matters, to deposit them on these enveloping structures, and thus purified it is fitted for the functions of digestion.

Had the blood been sent to the stomach and intestines, as it is to the heart, kidneys, and other organs,—that is directly and without the medium of the annexed membranes, in certain conditions of the body they would have been incapable of performing their office. That of the stomach is the secretion of gastric juice, the production of which requires that the arterial fluid shall abound in vital properties: an excess of carbon in its constitution would have vitiated the secretion, and rendered it unequal to the duties imposed upon it.

The intestines, in the advanced stages of digestion, are engaged in the absorption of chyle, and in the transmission of it through numerous channels;—actions which could not possibly have been carried on with any degree of efficiency, had the blood in its impure state, as is the case when predisposed to the growth of fat,—been conveyed to these organs. The Omenta and Mesentery are the structures through which it has to pass, and the copious deposition of fat in them, which invariably occurs when the constitutional tendency for its production exists, is to this extent a relief to the viscera in question. This view opens out fresh ground for investigation. It places the mind on a new track of research.

It could scarcely have been imagined, had the subject been studied with attention, that among the most important

uses of the Omenta and Mesentery, are the lubrication of surfaces, the filling up of interstices, and the retention of heat; effects of trifling moment compared with the functions here ascribed to them. The Omenta and Mesentery are the supplementary provisions of the viscera,—their safety-valves; and in certain conditions of the animal system are necessary to protect them from influences that would otherwise be fatal to life.

The Omentum, as we have stated, has its divisions, which receive designations according to the viscera with which they are in close relation. These several divisions do not equally exhibit the presence of fat. The greater or less development of it, in the different omenta, will depend on the vital requirements of the organs to which they are appropriated. The colon, for example, in addition to the great omentum, and the omentum colicum in direct connexion with it, has fatty and membranous processes hanging from its surface, and termed *appendices epiploicae*.

The omenta and mesentery, on these views, are appendages, the office of which is to protect internal structures against the effects of a morbid state of the blood. They withdraw from it those materials which go to the formation of fat, and hence the absence of this in the ordinary secretions of the intestines.

It is scarcely needful to observe, that in persons grossly corpulent, and in cattle slaughtered for domestic purposes, the membranes alluded to are loaded with fat, and according to its accumulation is their capacity manifested as safety-valves of the intestines. As the blood has to pass through them previous to reaching the bowels, is it not rational to

suppose, that a portion of the carbonaceous elements it possesses,—in excess from the properties by which it is distinguished,—will be arrested in their transmission, and to this extent will be a relief to the organs of digestion?

The argument which is here employed receives support from the fact, that the omenta are more largely developed in the herbivora than the carnivora. The former, from the nature of the food on which they subsist, will give rise to a condition of the blood very different from that of the latter. It will have carbon in far greater copiousness; and hence the facility with which animals of this class are fattened. From this cause, a more urgent necessity will exist for the greater amplitude of the supplementary structures.

Had not these or analogous appendages been present, the intestines, under particular circumstances, would have secreted fat. Superfluous chemical elements could not otherwise have been disposed of. Had they been conveyed to the stomach and intestines, as they are to the heart and kidneys, fat in some form or state would have been thrown out in connexion with them.

The truth of a principle may generally be tested by the extent of its application to the elucidation of phenomena. The greater the number which it is capable of embracing and shedding light upon, and the higher are its claims to consideration. We have remarked, that had the alimentary canal received blood direct, and not through the media of the accessory organs, in certain states of the body, it would have secreted fat. This, in fact, does occasionally occur both in man and the lower animals. It is expelled by both, and by some of the latter in extraordinary quantity.

Its production in both has given rise to various speculations, in the attempt to account for it, but none which are regarded as at all satisfactory.

Cases have frequently been described, in which oily and fatty substances have been evacuated by patients, varying in size from a pea to a marble. As far as the symptoms are given it is evident that the abdominal viscera were greatly disordered.

The presence of these matters in the motions is not difficult to explain on the views brought forward. The omentum or mesentery, on these occasions is in too *diseased* a state to exercise its ordinary functions in relation to the intestines; consequently blood is transmitted to the latter in such a condition of impurity as to account for the secretion of fat. This never, in such a form, occurs in health, nor is it observed, except in connexion with obvious disease of the abdominal viscera.

This explanation is strengthened by what takes place in some of the lower animals. Fatty substances are discovered in immense quantity in the Spermaceti whale, and in the whale tribe generally. In the intestines of the former, masses of ambergris, a hundred pounds weight, are occasionally found, and are said to be more perfectly elaborated the more sickly and costive the animal is. Spermaceti contains sixty per cent. of fat.

The whale tribe are remarkable for the oil and fat they produce, and when these can no longer be employed in the development of the body, indisposition is the consequence. The system must be relieved of its surplus matters, *and it is in the intestines only that they can find an issue.*

The next organ we propose to examine, in connexion with these researches, is the liver, which, from its functions, possesses no ordinary interest. It differs in several essential respects from the organs of which we have already treated. Its office, like that of the kidneys, is to secrete; but while the fluid of the one is thrown out of the body, that of the other is substantially retained. In the case of the kidneys, a supplementary appendage is necessary to protect them against the baneful influence of morbid blood,—its tendency to the growth of fat. In regard to the liver, no such provision is required, *the biliary secretion being largely composed of carbonaceous materials*; consequently, in the natural exercise of its functions, it is relieved of elements, which the heart and kidneys have no means of getting rid of except by the generation of fat.

It has long been a question agitated among physiologists, whether bile was derived from the arterial or venous blood,—a point which does not fall within the scope of this investigation, beyond its relation to the physiological principles which are here laid down. From these it is evident, that nature adopts various expedients, in order to emit refuse elements resulting from excited or concentrated vital actions, a great proportion of which is carbon, which we have shown has issues in the formation of various substances.

The blood flowing from the extremities and the abdominal viscera, has to pass through the liver before it can reach the heart and lungs; and the mode in which it is distributed throughout its tissue, would appear clearly to indicate that the course which it takes, is to deprive it of particular elements previous to its transmission to the respiratory

organs. The veins which enter the liver, divide and subdivide after the fashion of arteries, into extremely minute branches, from which the blood is collected and conveyed to the lungs. Why this elaborate circulation, *if not for the extraction of surplus matters?*

This view of the subject has been strongly insisted upon by physiologists, who entertain the opinion, that bile is eliminated from venous blood: the fact that it is principally formed of carbon, goes far to prove that this is the source from which it is derived, and not the arterial fluid. The former has carbonaceous elements in abundance; the latter clearly not in the healthy conditions of the body. The contents of the one class of vessels, are returning in order to be relieved of them; those of the other, are on their passage to every organic molecule, rich in the properties of life.

The liver stands in the same relation to the lungs, that the omentum and mesentery do to the alimentary canal. The office of the former is to withdraw carbon from the venous blood, and it escapes in the form of bile into the duodenum, where it disappears in the successive stages of digestion. These observations in reference to the functions of the liver, may be materially strengthened by considerations which have scarcely arrested the attention of the physiologist. The phenomena to which we shall allude have certainly not been seized in their practical application to this subject.

The liver is liable to frequent derangement, in which the bile, whether redundant or not, is impeded in its exit from it. The latter circumstance often occurs in persons suffering from gall-stones; or these are subsequently the consequence of the repeated disturbance of the hepatic functions, and their

origin may be accounted for as follows: in all these cases the liver becomes congested, and at length permanently enlarged, which will impede the free escape of carbon from the blood according to the healthy requirements of the viscus, and of the animal system generally. This functional disturbance will give to the bile secreted properties which it does not ordinarily possess: it will have some elements in excess. On reaching the gall-bladder, where a great portion of it is retained beyond the usual period, from the altered constitution of it, and the circumstances in which it is placed, new chemical affinities are created, and the result is the formation of gall-stones. What are these substances? When analysed they are found to be composed chiefly of carbon and its products. The composition of them throws light on the functions of the liver, and the nature of its frequent disorders.

The subject may be studied under other aspects, and important in their relations to this inquiry. In certain morbid states of the liver, in which the secretion of bile is either in great part or entirely suspended; the body, if it does not acquire additional flesh, retains its ordinary plumpness during long and severe attacks of disease, that would, were the functions of the liver carried on with any degree of activity, be accompanied with considerable emaciation. We will give an instance in point.

A short time ago we were in daily attendance on a lady, fifty-four years of age, suffering from violent paroxysms of pain in the epigastric region, with only slight remissions during the twenty-four hours. She had already been confined to bed nearly a month, and affected in the way

described. Active internal and external remedies had been employed, but without any relief to the symptoms. We attended her for three weeks, in conjunction with the gentleman who had treated her from the first, at the end of which period she died. The pain throughout the whole of her illness continued uniform in character and severity. We may state, that the sufferings were ascribed to the presence of gall-stones.

The patient was of the lymphatic temperament, short in stature, somewhat inclined to corpulency, but in health did not exhibit any striking evidence of it. It was remarked, that she did not appear to lose flesh; and hence hopes were entertained of a favourable termination of the disease. The diet had been tea, puddings, and gruel, taken at long intervals, and in exceedingly small quantities. The bowels were constipated, and when acted upon, the motions were like those of an infant. The complexion was sallow, but scarcely to a degree to indicate a bilious tendency.

At the request of the family the body was examined. The parietes of the abdomen were found fully two inches thick in fat, and the limbs had apparently their usual development. The Omentum and Mesentery had likewise an abundance of fat. Five gall-stones were found impacted in the *ductus communis choledocus*, obstructing the escape of bile, of which, however, the gall-bladder contained only a small amount. Eleven or twelve distinct abscesses were discovered in the liver, several of which exceeded the size of a walnut, filled with a greenish kind of pus, which was also infiltrated throughout the whole of the hepatic tissue.

This case is introduced from its intimate connexion with

the present inquiry. It is clear, that the liver had for many weeks been incapable of secreting bile; consequently the carbon which would have been disposed of in its production, *was not withdrawn from the blood*. The retention of it in the circulatory system, according to the principles which are here advanced, would conduce to the stationary condition, if not the growth, of the adipose tissue.

The principles which are here advocated admit of further illustrations. The liver occasionally degenerates into a *fatty* state. This structural change has been mentioned by several writers, but has not at all been accounted for. An excellent authority, in describing the disease, observes: that "the organ is enlarged, leaves a layer of oily substance on the scalpel, renders the paper oily and transparent when warmed, and burns in the flame of a candle when its aqueous particles are evaporated; it swims upon water. *It is unattended with icterus*. It occurs principally in phthisis."*

The secretion of fat depends on the presence of carbon in the blood, and the degree in which it is developed, shows the extent to which this chemical element predominates in the circulating fluid. In phthisis, the lungs are largely destroyed or unequal to the performance of their functions. This condition will interrupt the free escape of venous blood from the right cavities of the heart, *and in this manner will occasion congestion of the liver*, which will not possess the usual facilities for relieving itself of the blood that passes through it in its course to the heart; consequently

* The Principles of Diagnosis. By Marshall Hall, M.D., F.R.S. Vol. ii., p. 269.

hepatic congestion will necessarily occur, though only occasionally in such a way as to arrest the attention of the practitioner. The reason is obvious. The production of blood, in phthisis, is not equal to its expenditure during the progress of the disease; and, therefore, though the motion and distribution of it are greatly disturbed, yet from the limited quantity in circulation, congestion of the liver will seldom present itself in a marked degree.

In the investigation of this subject we have three causes to study: the structural condition of the lungs, the influence they exercise, and the congestion of the liver.

The state of the lungs will not allow the blood to enter them according to the diminished necessities of the *vena cavae*. It will be thrown back in the direction of the liver, impeding the flow of the venous currents from it, and in consequence will give rise to hepatic congestion. The frequent and severe fits of coughing to which the patient is generally subject, will, independently of the structural changes of the lungs, disturb the transmission of the blood towards the heart, and will be a further cause of the organic and functional derangement of the liver. The accumulation and stagnation of blood in it, will, in the ratio in which they occur, interfere with the escape of carbon from it, *the retention of which will explain the degeneration of the hepatic tissue into a fatty substance*; and likewise the formation of gall-stones.

In further confirmation of these principles, we may quote the remarks of Lobstein. "Le foie," he observes, "est aussi dans quelques cas, le siège de la substance lardacée, c'est moins souvent à son bord supérieur et obtus, qu'à son

bord tranchant et autour de la vesicule du fiel, qu'on la recontre."*

The region where the transformation is most commonly remarked, is clearly where the bile will be most abundant, and where it is most liable to accumulate, whenever its transmission in the direction of the duodenum is interrupted. Hence the greater frequency of the structural alteration in this situation.

In the vital actions of every tissue carbon in some form is thrown off. It is scarcely possible to contemplate any of the processes of life, without perceiving the disengagement of it in some of its numerous combinations.

Organs differ greatly in structure, functions, and the circumstances in which they are placed; and from these causes arises the diversity of the modes in which a predominant chemical element is expelled, or the supplementary conditions which it assumes. The long bones add another illustration to the views brought forward. In the young and vigorous they are richly furnished with arterial blood, and the actions to which it contributes transform it into venous. Independently of this conversion, by which carbon may be supposed to be imparted to the latter, this substance has to be emitted from the region where the vital operations are carried on. In conjunction with other elements, it finds an issue in the production of the marrow of the bones, which in relation to them is an *appendage*, increasing and diminishing according to the prevailing conditions of the animal system.

* *Traité d'Anatomie Pathologique.* Vol. i., p. 394.

When the body is no longer supported from without, whether from the want of food or the decay of its powers, it begins to live upon itself. It is tenacious of existence. It draws supplies from various sources, and among the rest from the bones themselves. The animal substances, after serving a temporary purpose, are expelled, but not in a structural form.

THE END.

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